

# KRASOSLOVJE NA KLASIČNEM KRASU

TADEJ SLABE

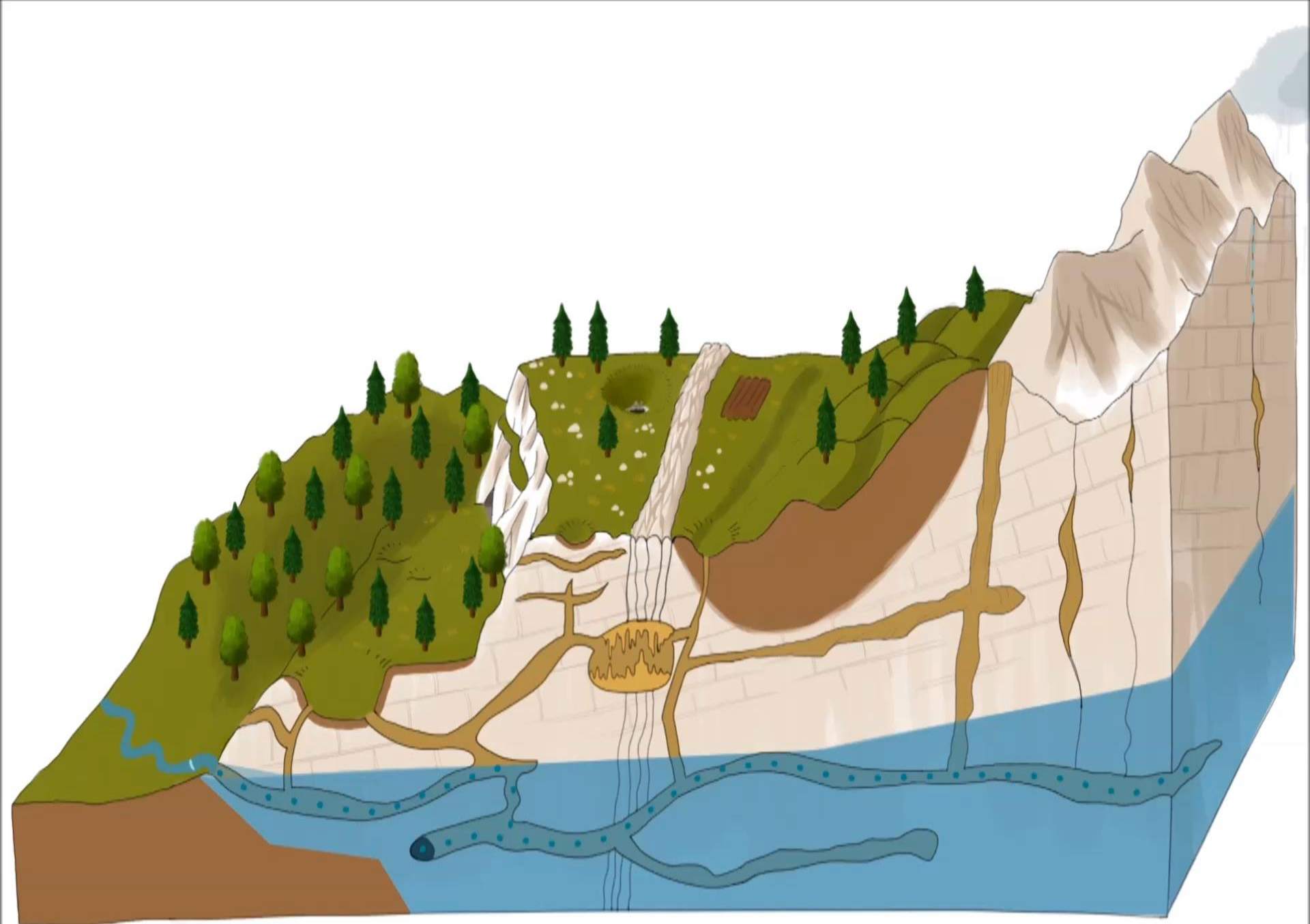
Postojna, junij 2022

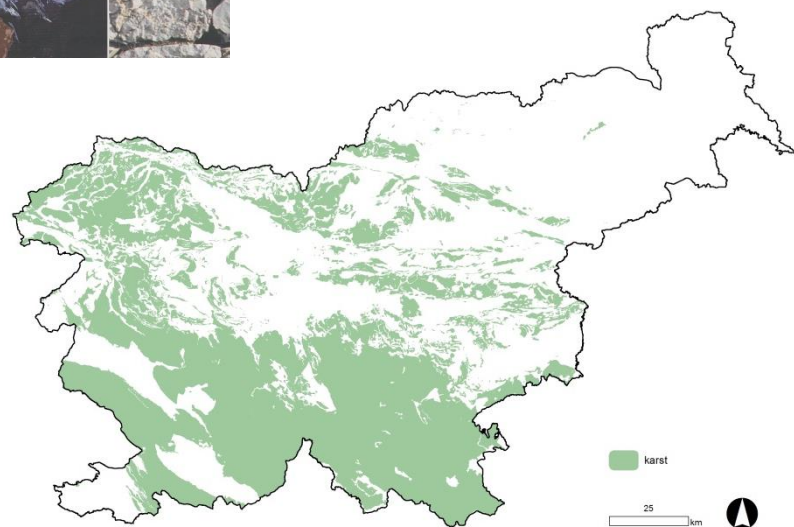
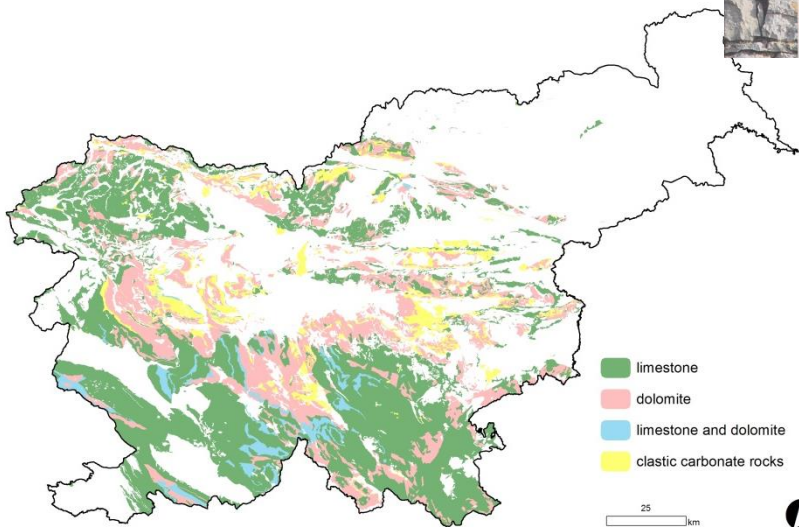
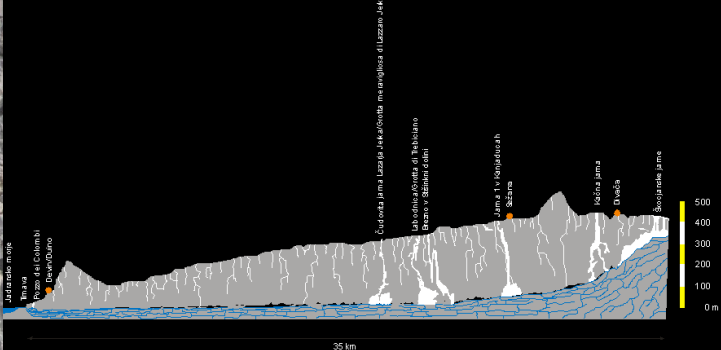
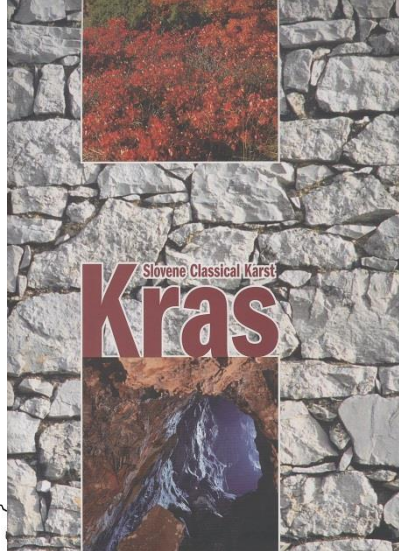


REPUBLIKA SLOVENIJA  
MINISTRSTVO ZA OKOLJE IN PROSTOR



ZRC SAZU  
Institut za raziskovanje krasa





47% (27% apnenec, 14% dolomit in 6% klastične karbonatne kamnine)

- Pomembna naravna in kulturna dediščina
- Ranljiva pokrajina

# Celostno krasoslovje

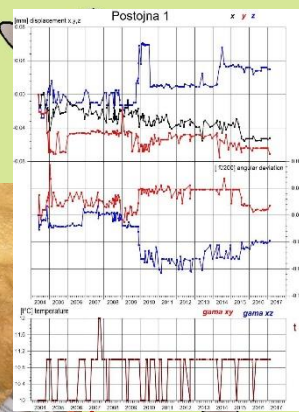
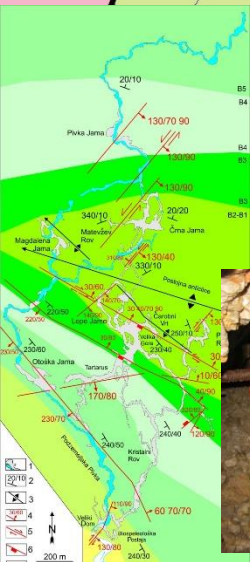
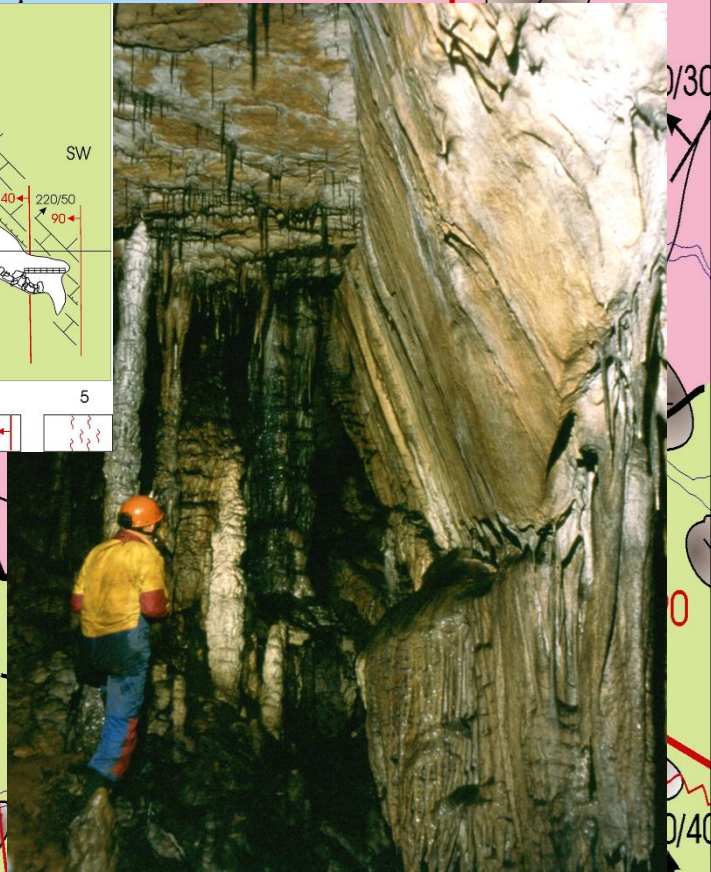
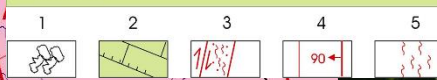
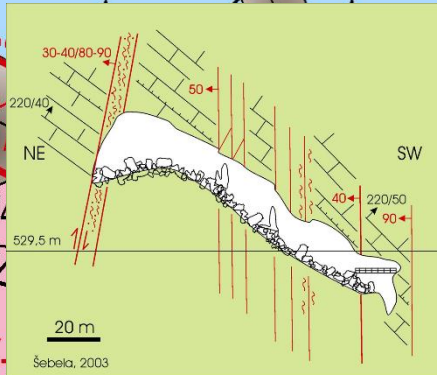
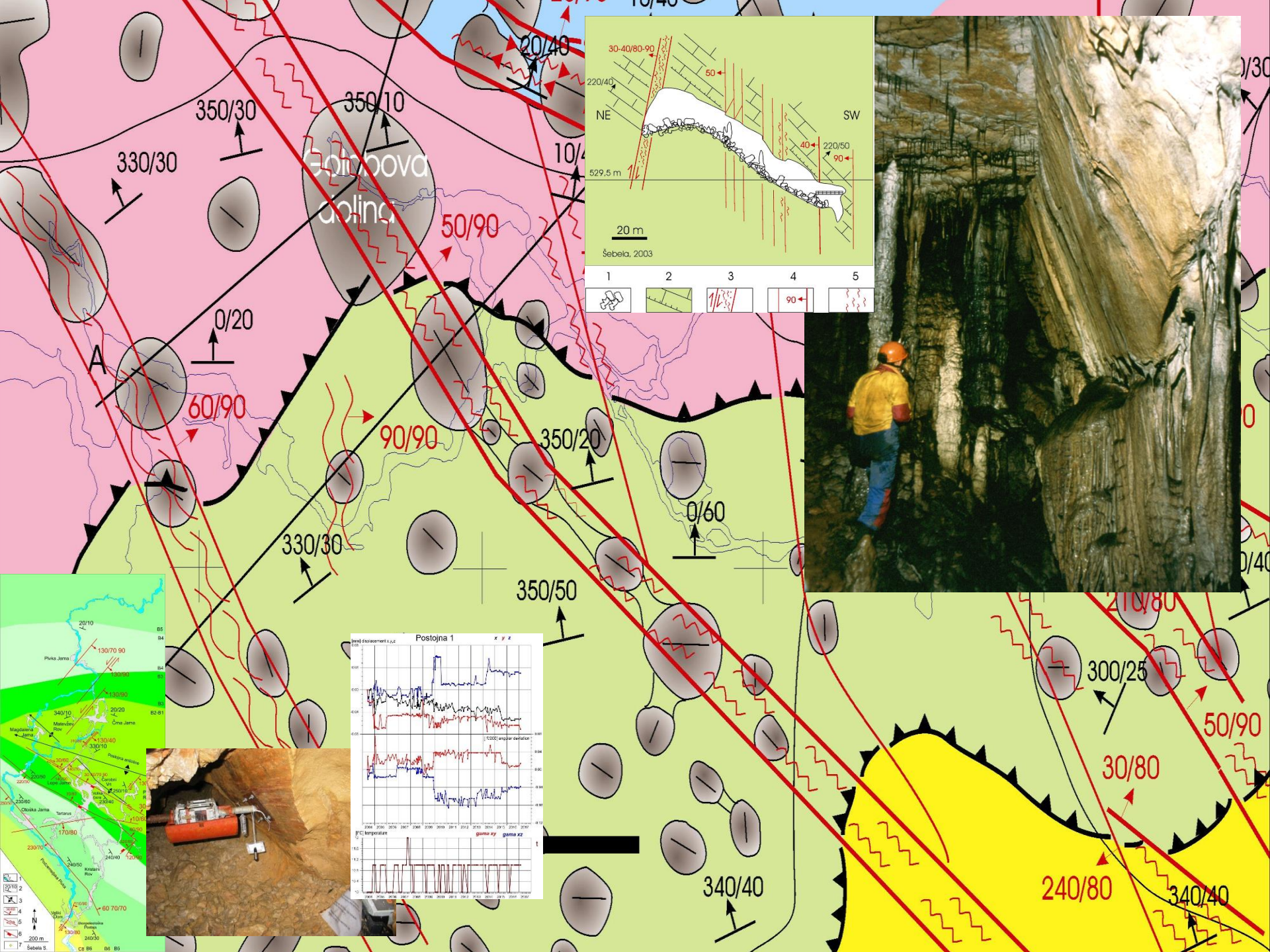
- Poglobljanje temeljnega znanja o naravni in kulturni dediščini krasa
- Celostno poznavanje in razumevanje kot izhodišče za dobro načrtovanje na krasu in njegovo varovanje
- Študij krasoslovja
- Infrastrukturne povezave: domače in mednarodne

# Raziskovanje krasa

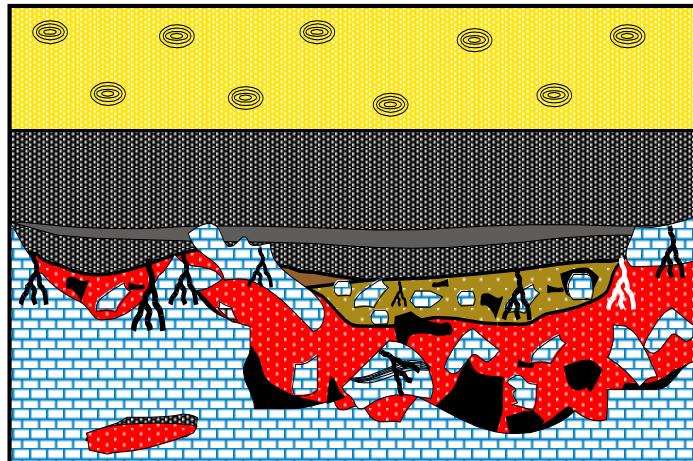
- Povezano raziskovanje (kraška geologija, k. geomorfologija, speleologija, k. hidrogeologija, k. biologija in mikrobiologija, ekologija ter razvoj krasa) za razumevanje trirazsežne pokrajine in dediščine.
- Razvoj načinov proučevanja: od terenskih z dolgotrajnimi opazovanji in merjenji do GISa in laboratorijskih ter matematičnih modeliranj.

# Razvoj kamnitega gozda na litološko različni kamnini, Šilin, Kitajska

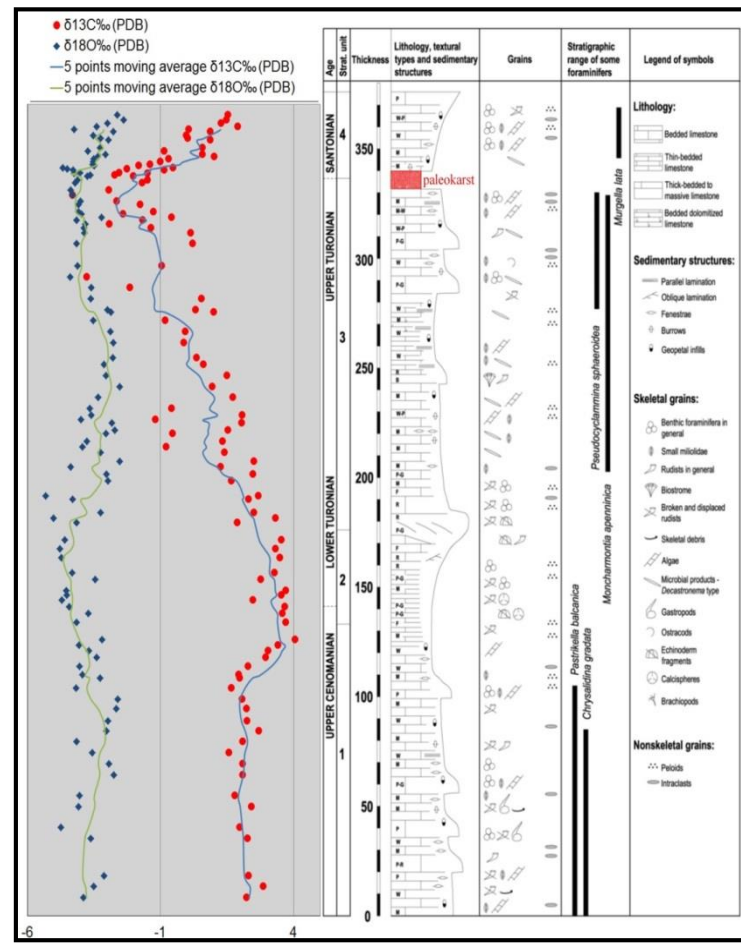
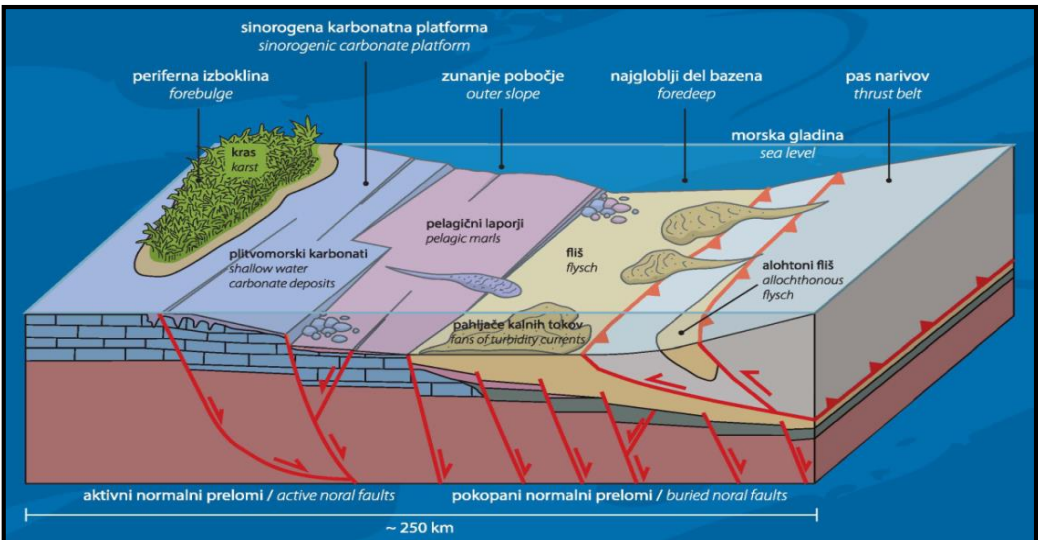




PALEOKRAS  
 SEDIMENTOLOGIJA  
 STRATIGRAFIJA  
 REGIONALNA GEOLOGIJA  
 GEOTEKTONIKA

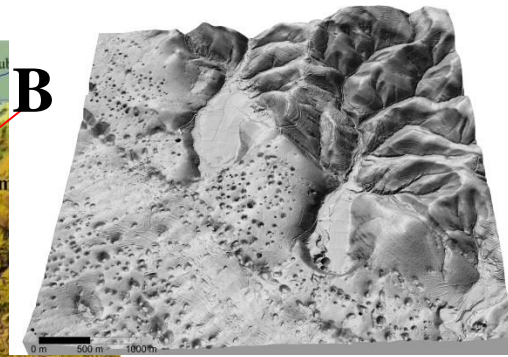
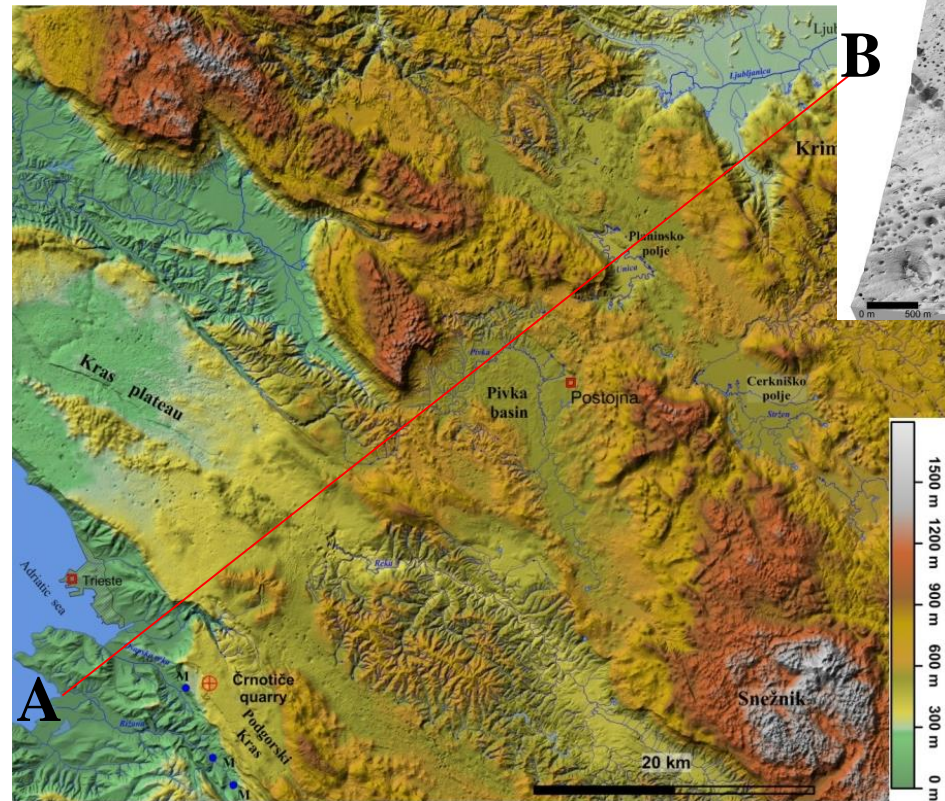


Raziskave pod in nad  
 paelokraškim površjem  
 z razvojem regionalne  
 neotektonike.





# Razvoj kraškega površja



Površje

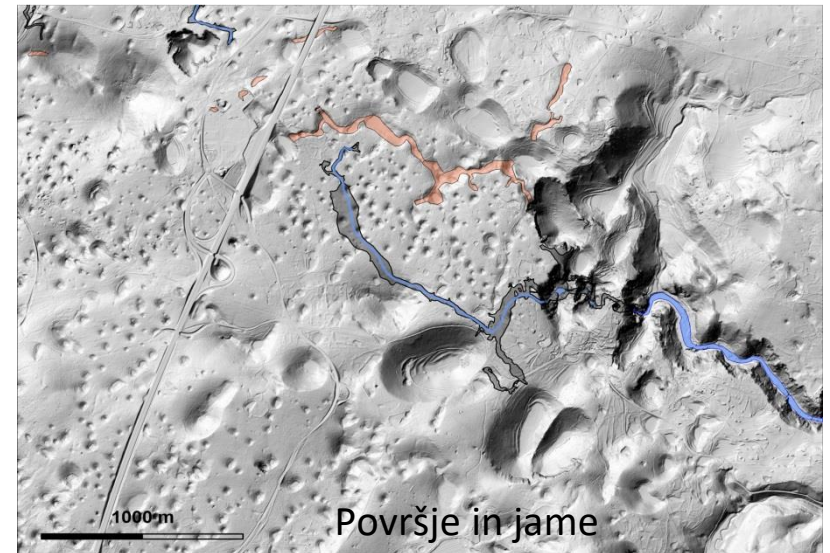
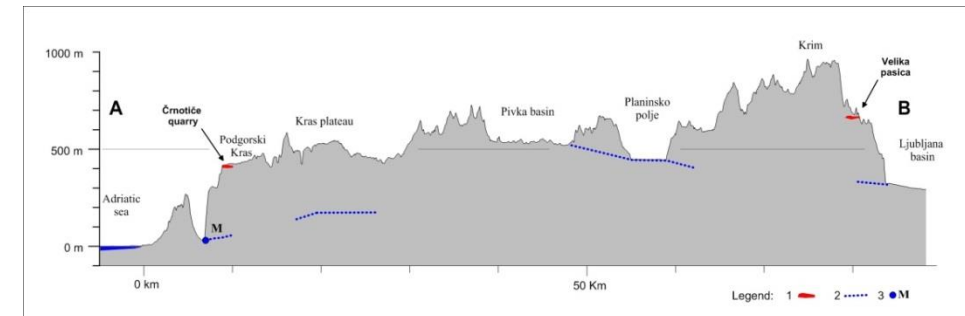


Jame



Jame brez stropa

## Celostni pristop

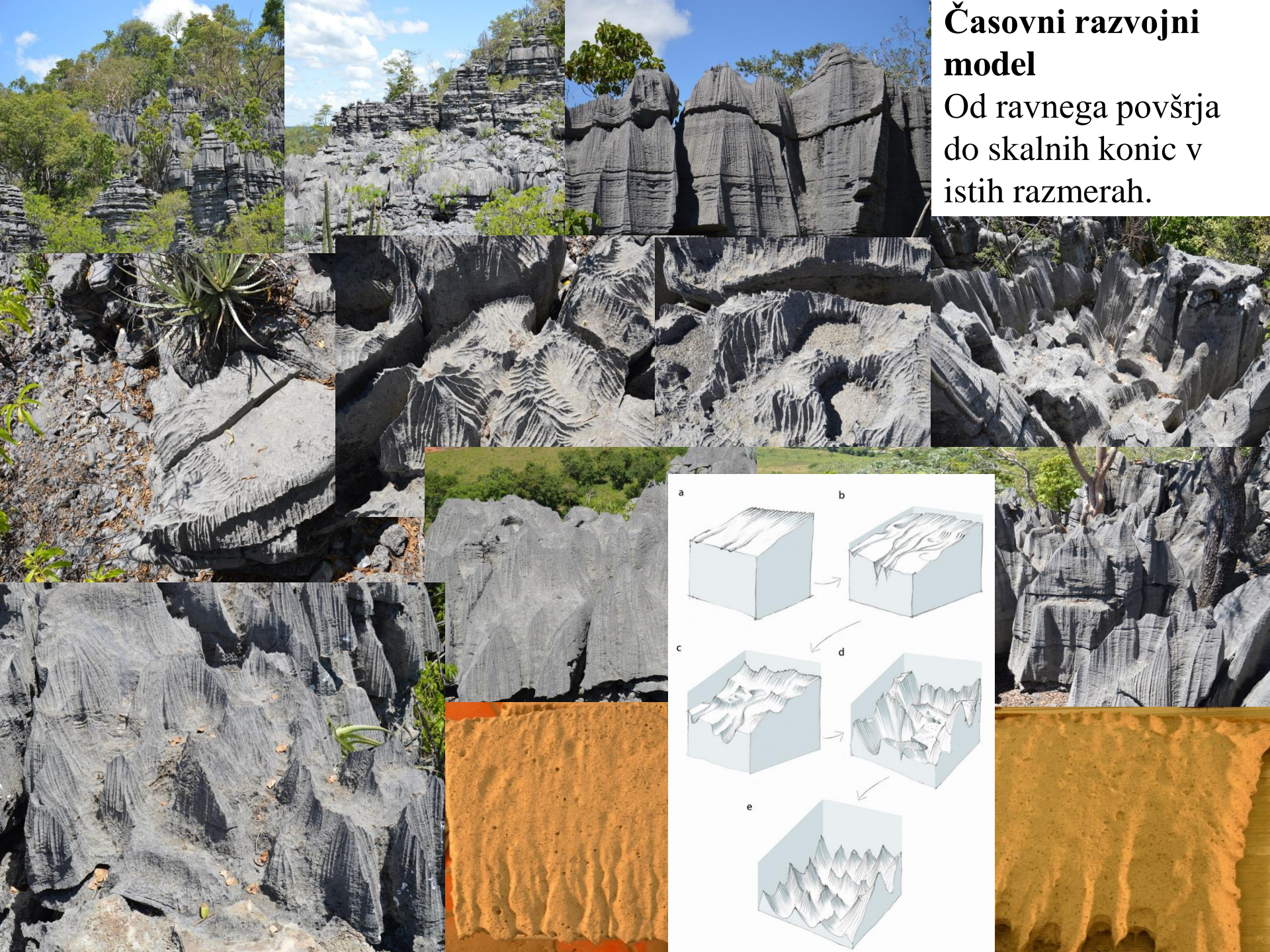


Površje in jame

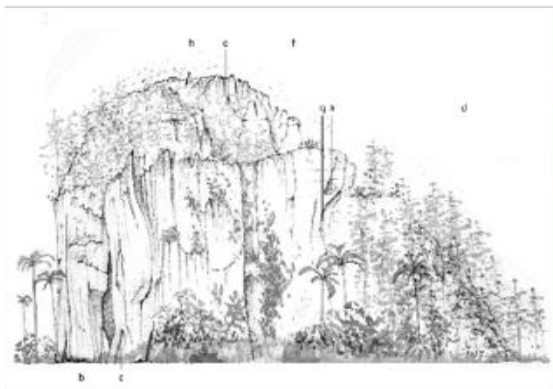


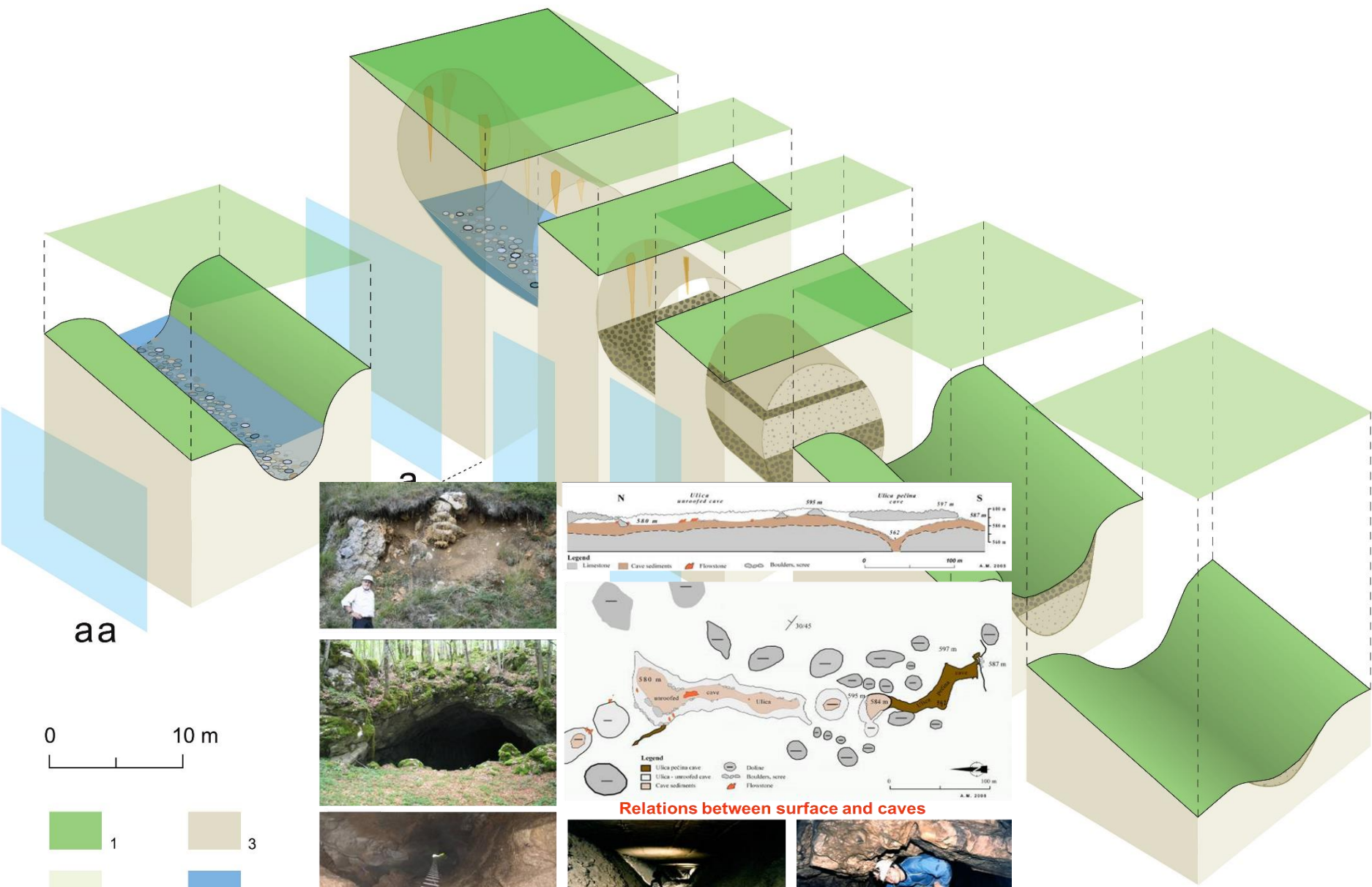
# Časovni razvojni model

Od ravnega površja do skalnih konic v istih razmerah.

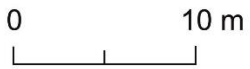


# Od Kube do Japonske

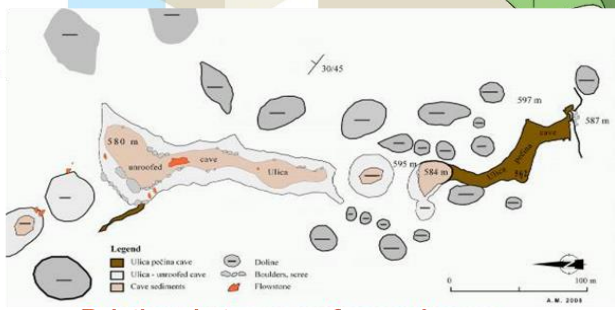
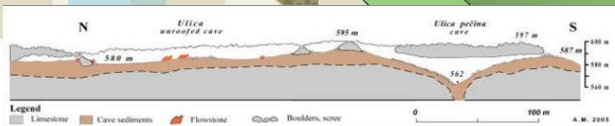




aa



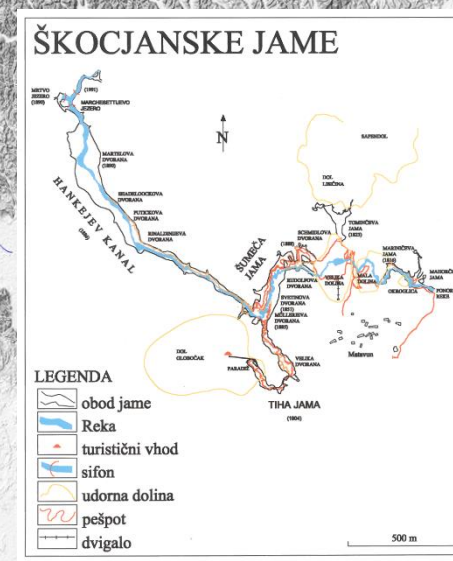
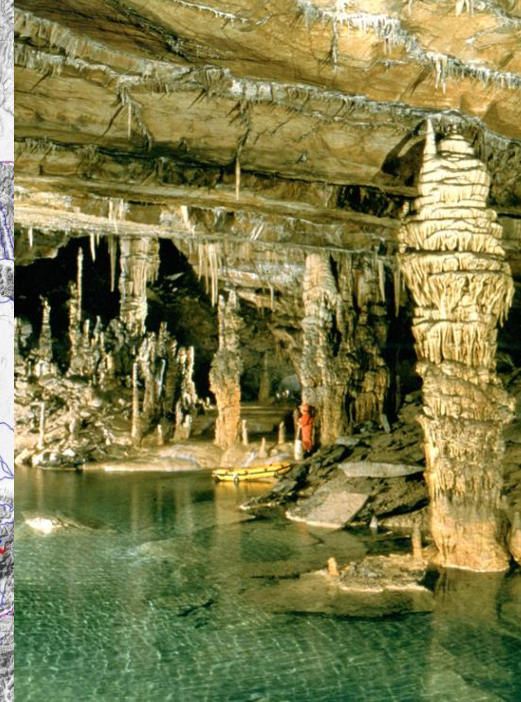
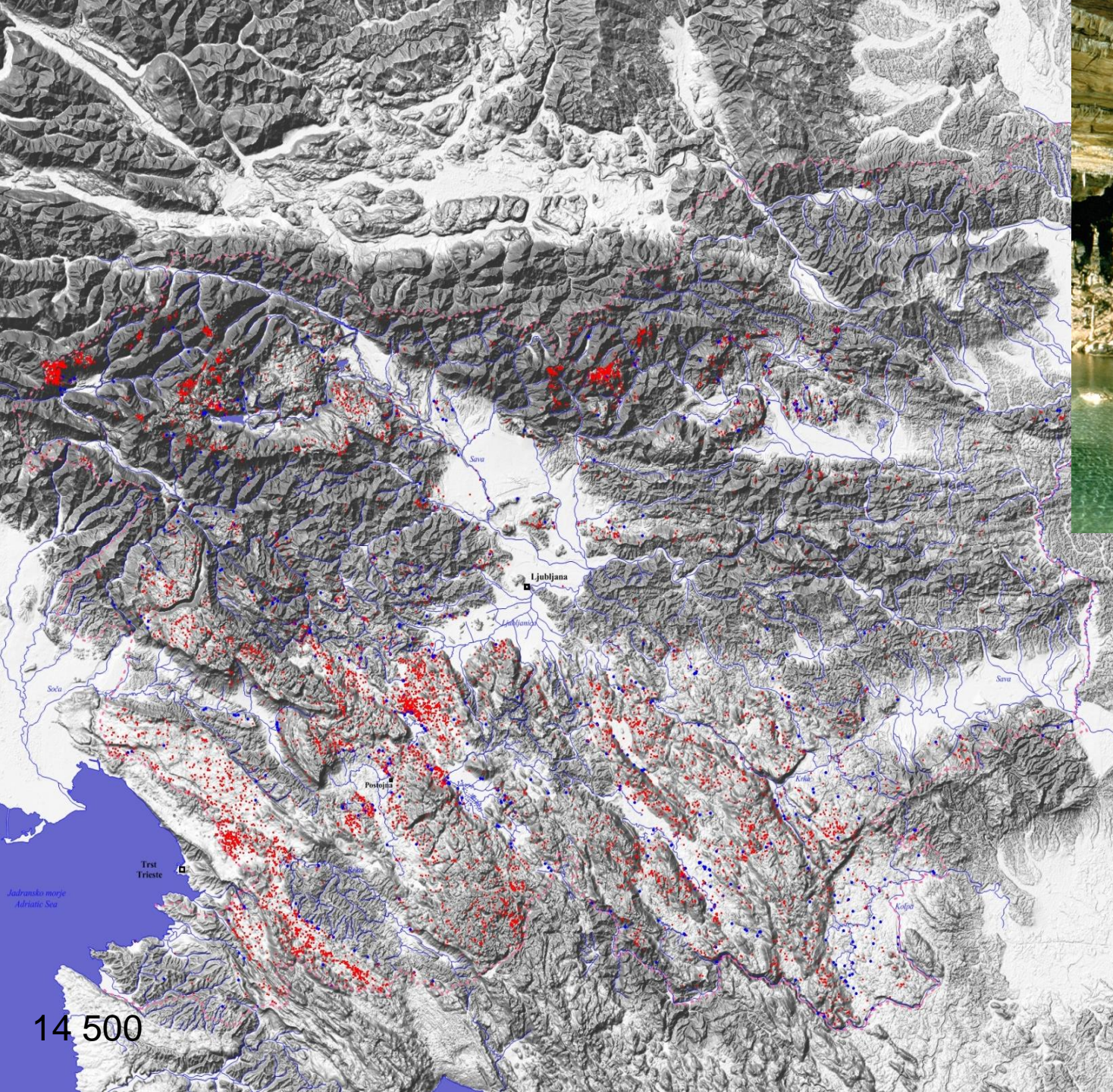
Andrej Mihevc



Relations between surface and caves



e



14 500

# Merjenje procesov zakrasevanja:

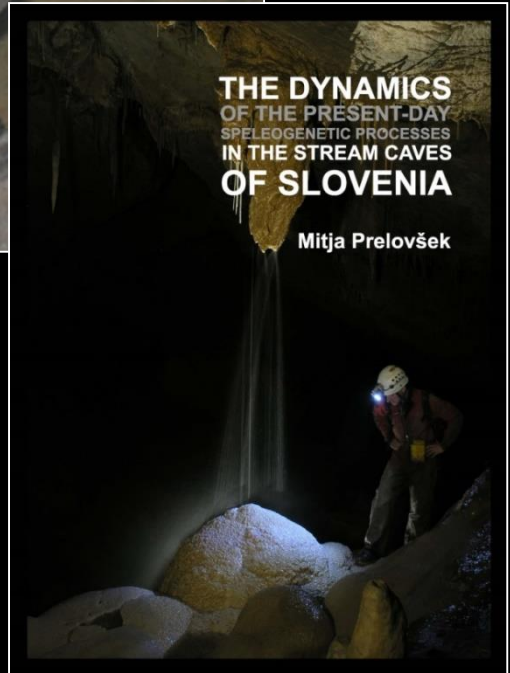
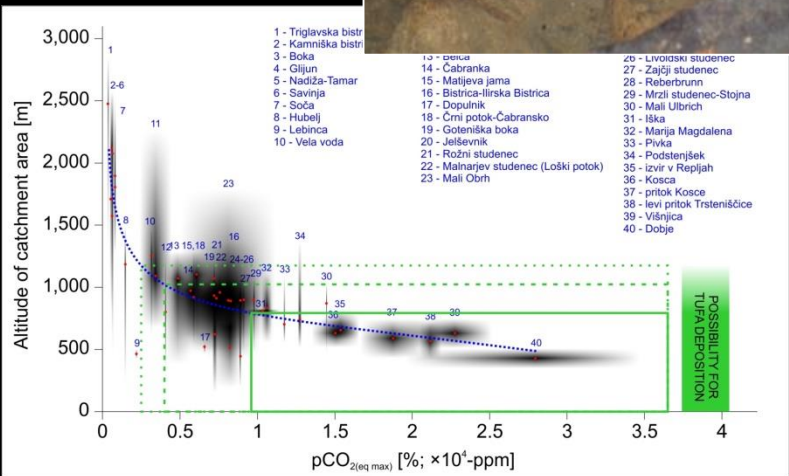
- Razvoj terenskih meritev raztapljanja kamnine in odlaganja sige (apnečaste ploščice → ±0.1 μm);
- Karbonatna geokemija (T, pH, SEC, HCO<sub>3</sub><sup>-</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, SI<sub>Cal</sub>, SI<sub>Dol</sub>, pCO<sub>2</sub>; );
- Količinski model krasa glede na prehod CO<sub>2</sub> med zrakom in vodo: geomorfologija in podnebje.

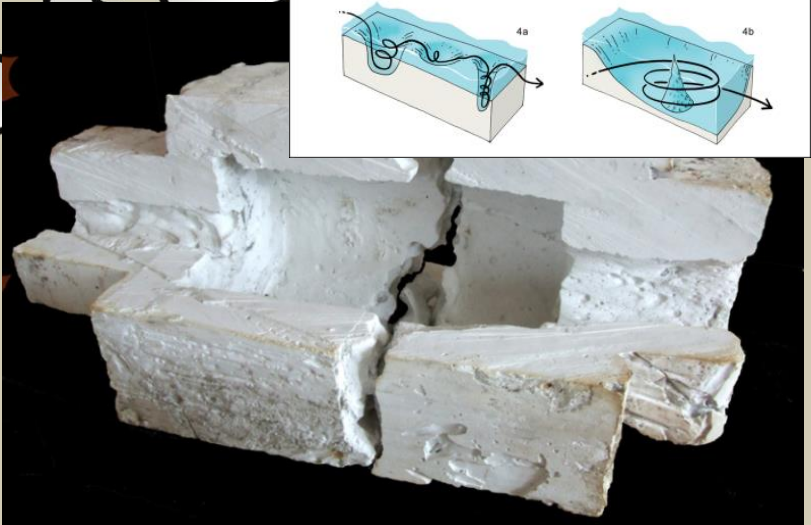
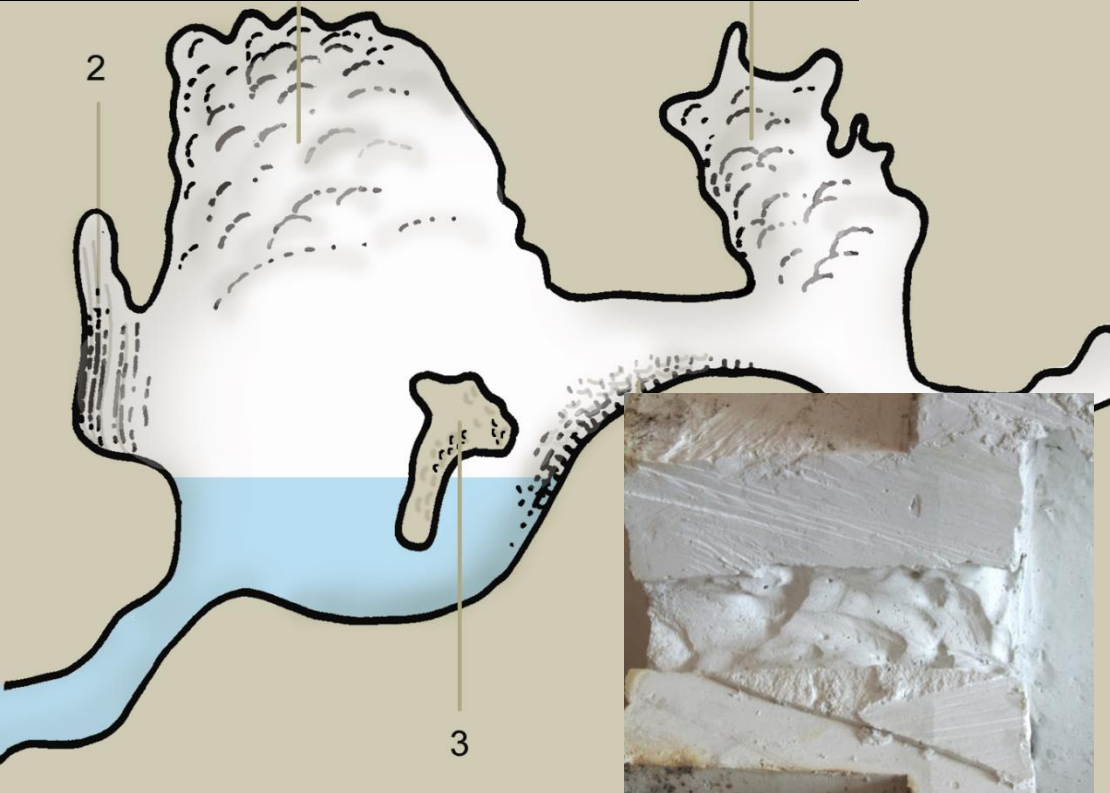
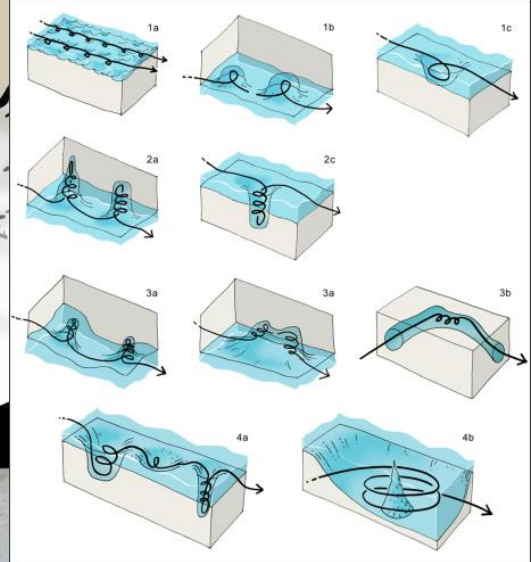


photo: A. Troha



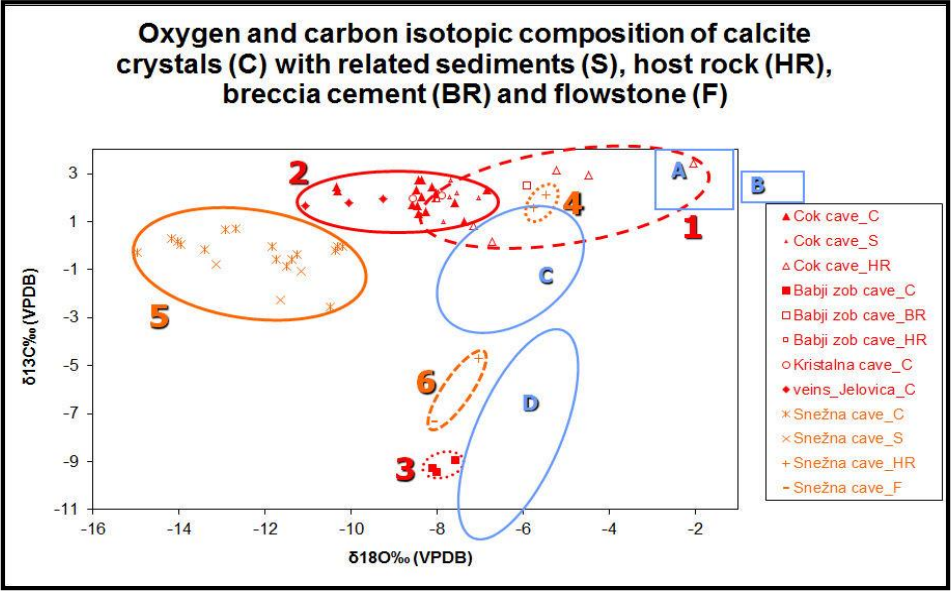
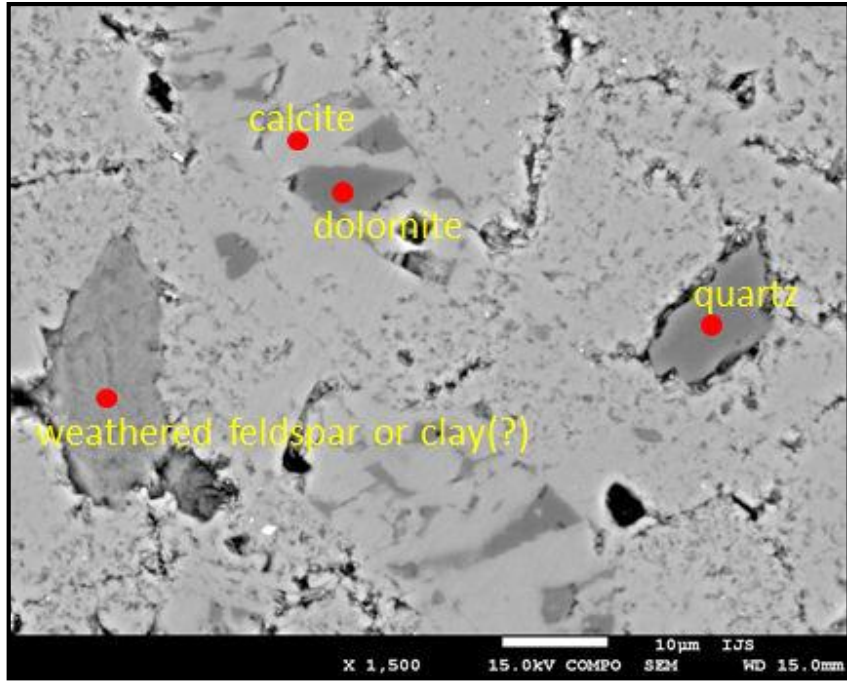
photo: D. Paar

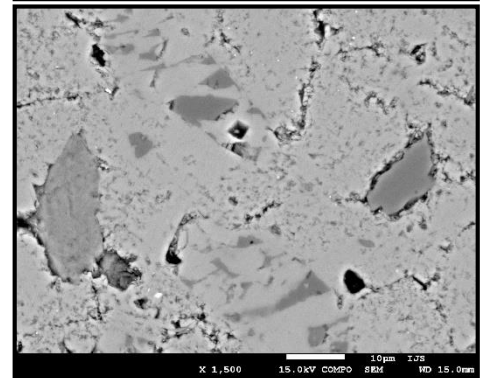
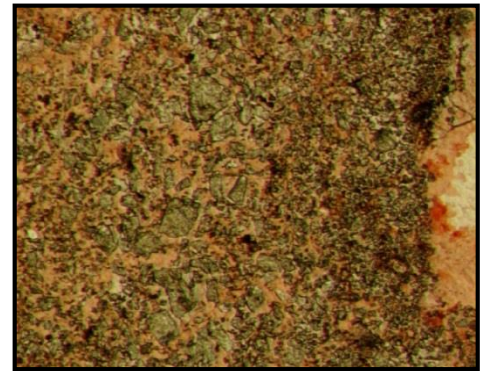
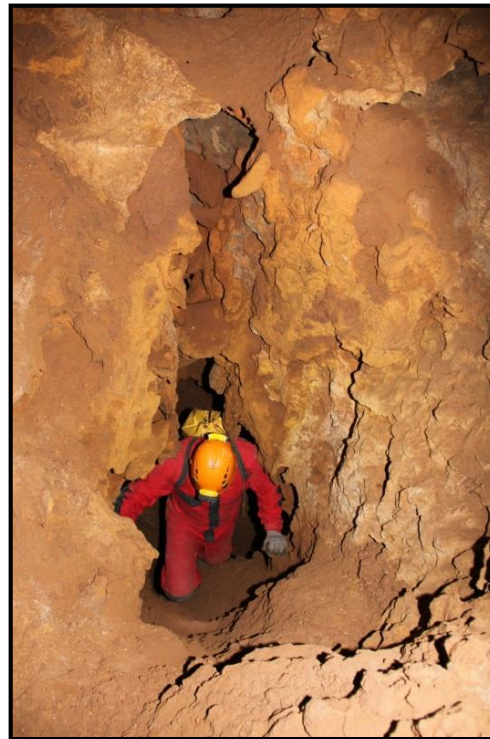
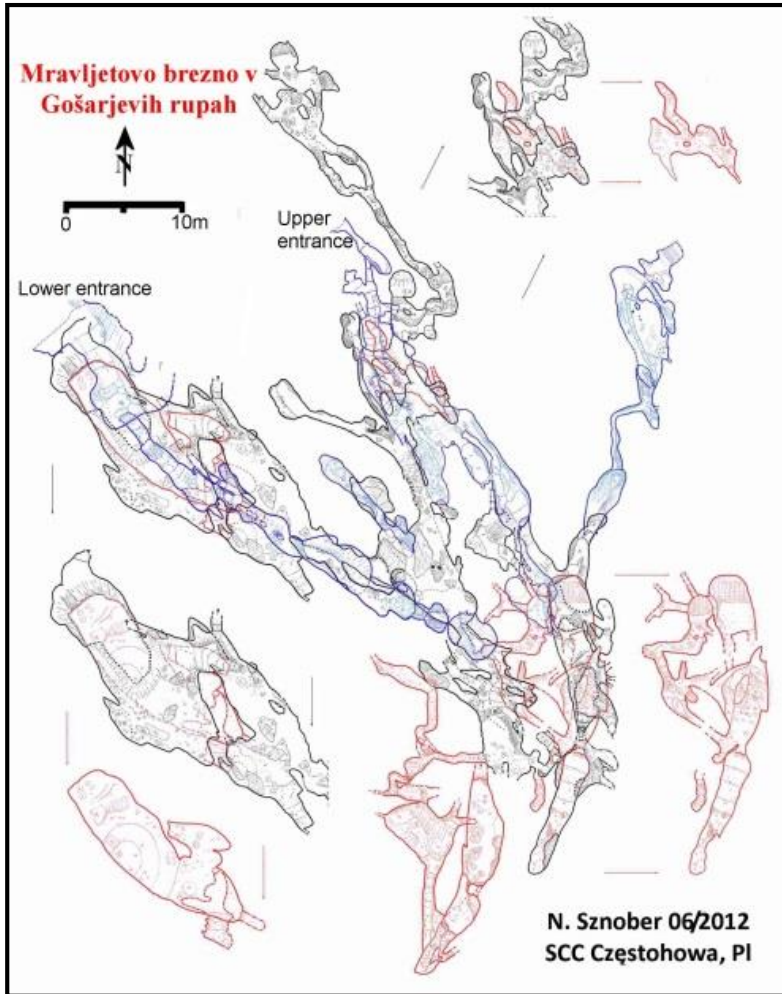




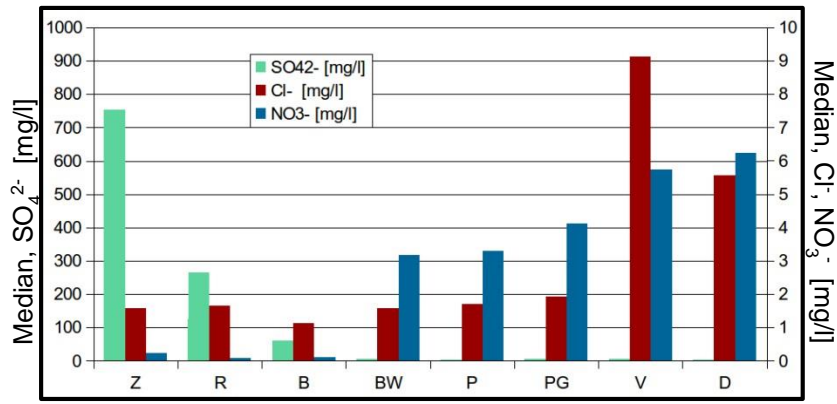


# Hipogena speleogeneza v Alpah

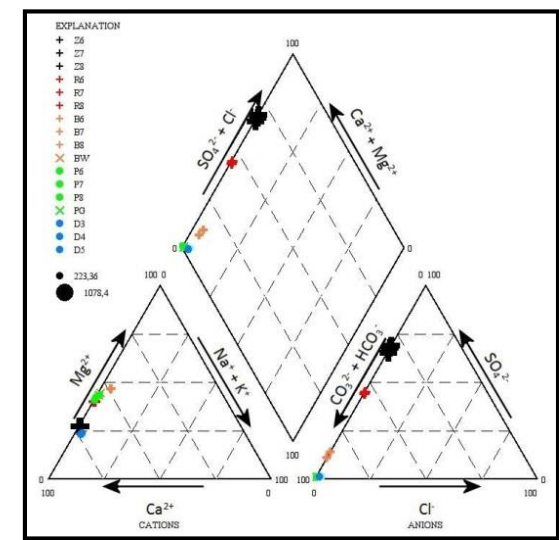




# Jame v dedolomitu

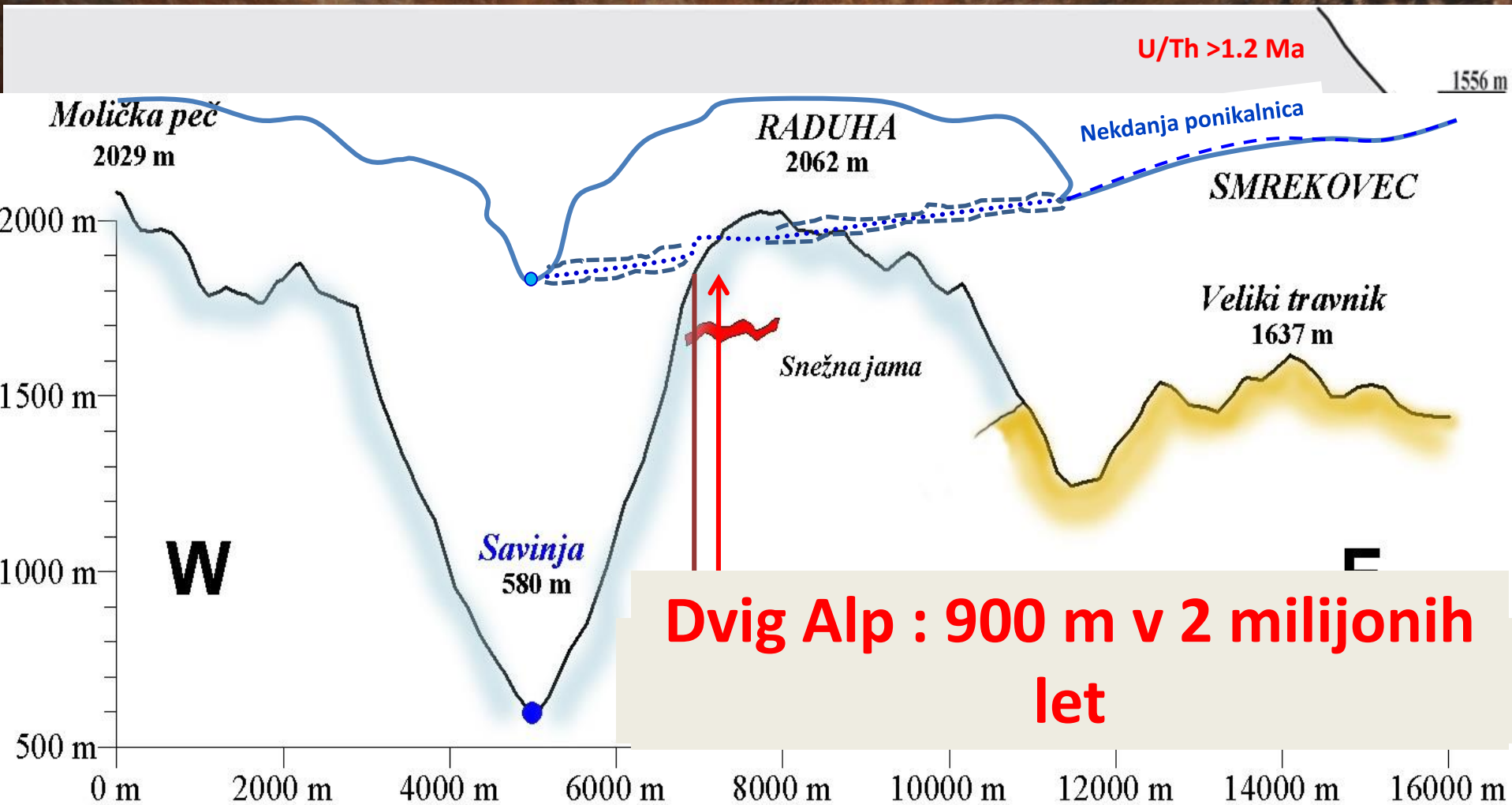


Median, Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup> [mg/l]



# Snežna jama

na Raduhi (Savinjske Alpe)

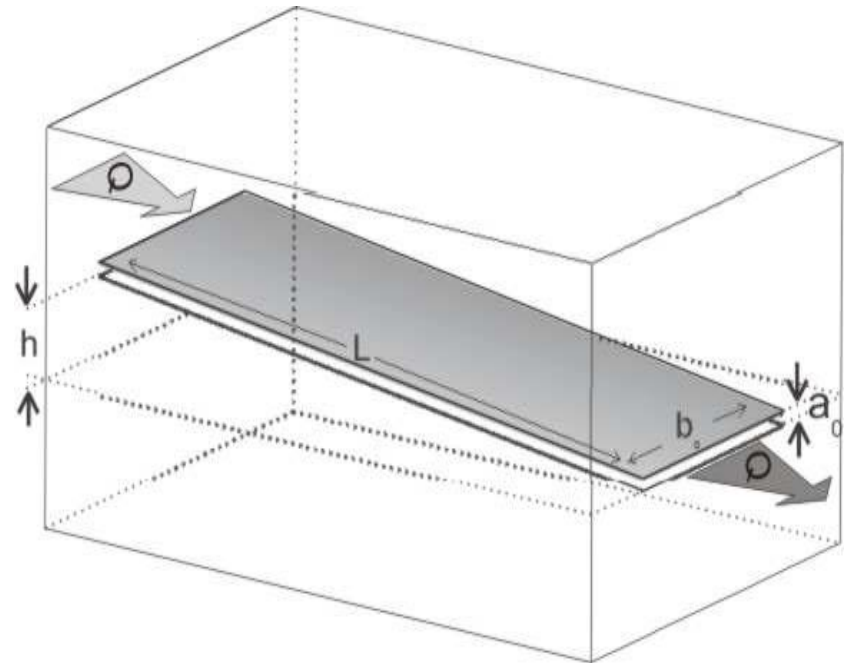
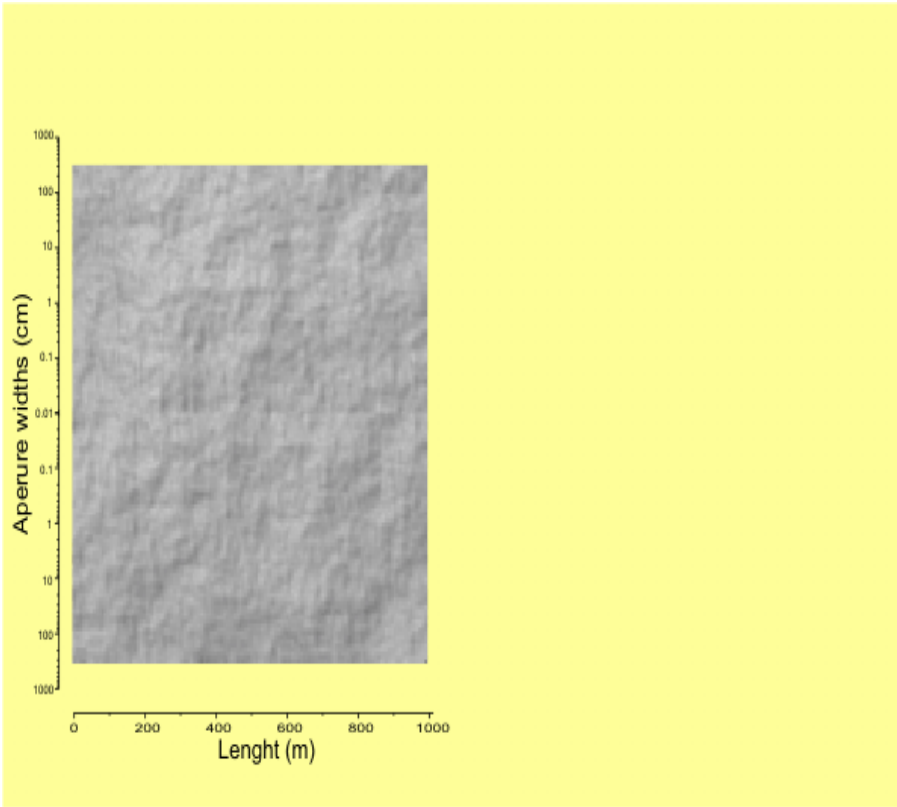


1 mm

4.0

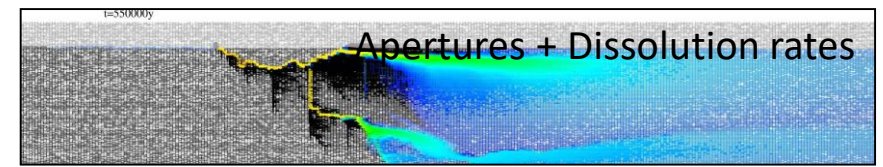
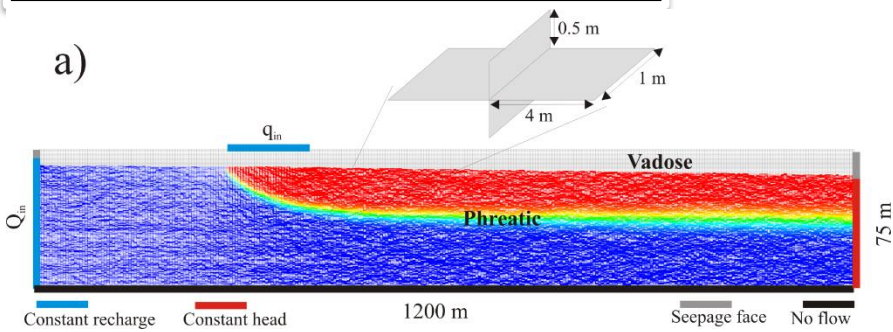
2 m

# Nastanek in razvoj jam

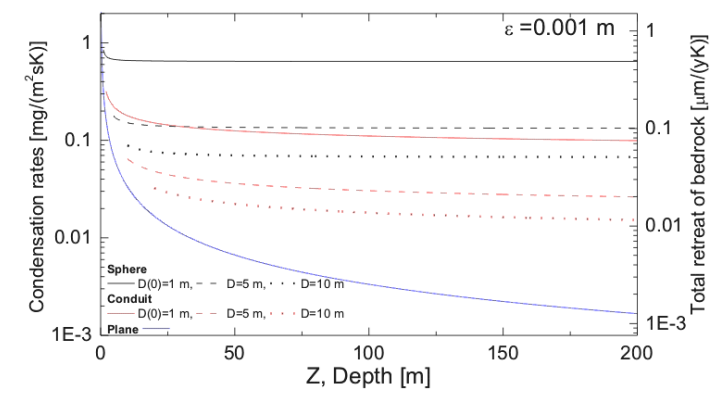
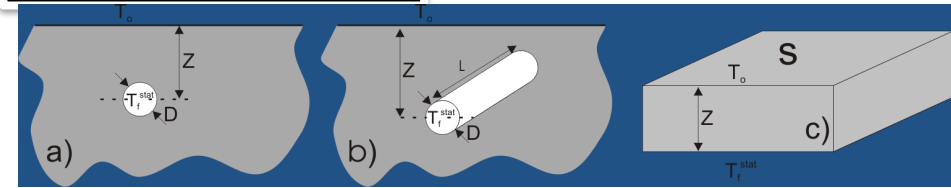


# Modeliranje procesov

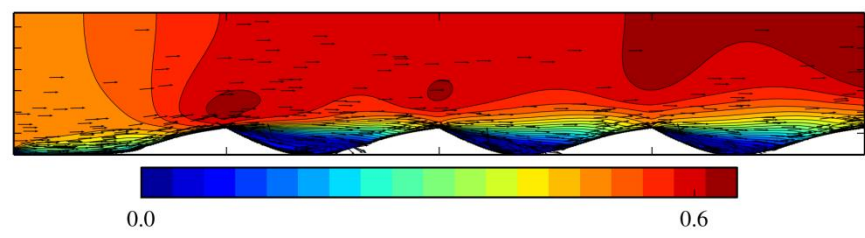
## Speleogeneza v različnih okoljih



## Kondenzna korozija



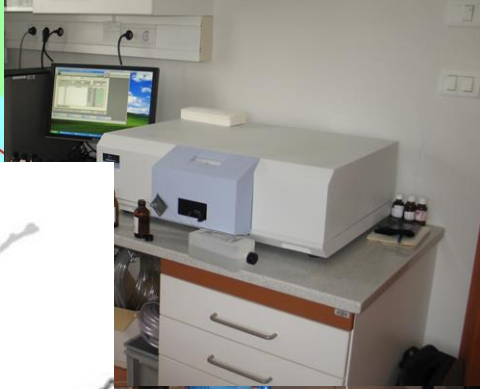
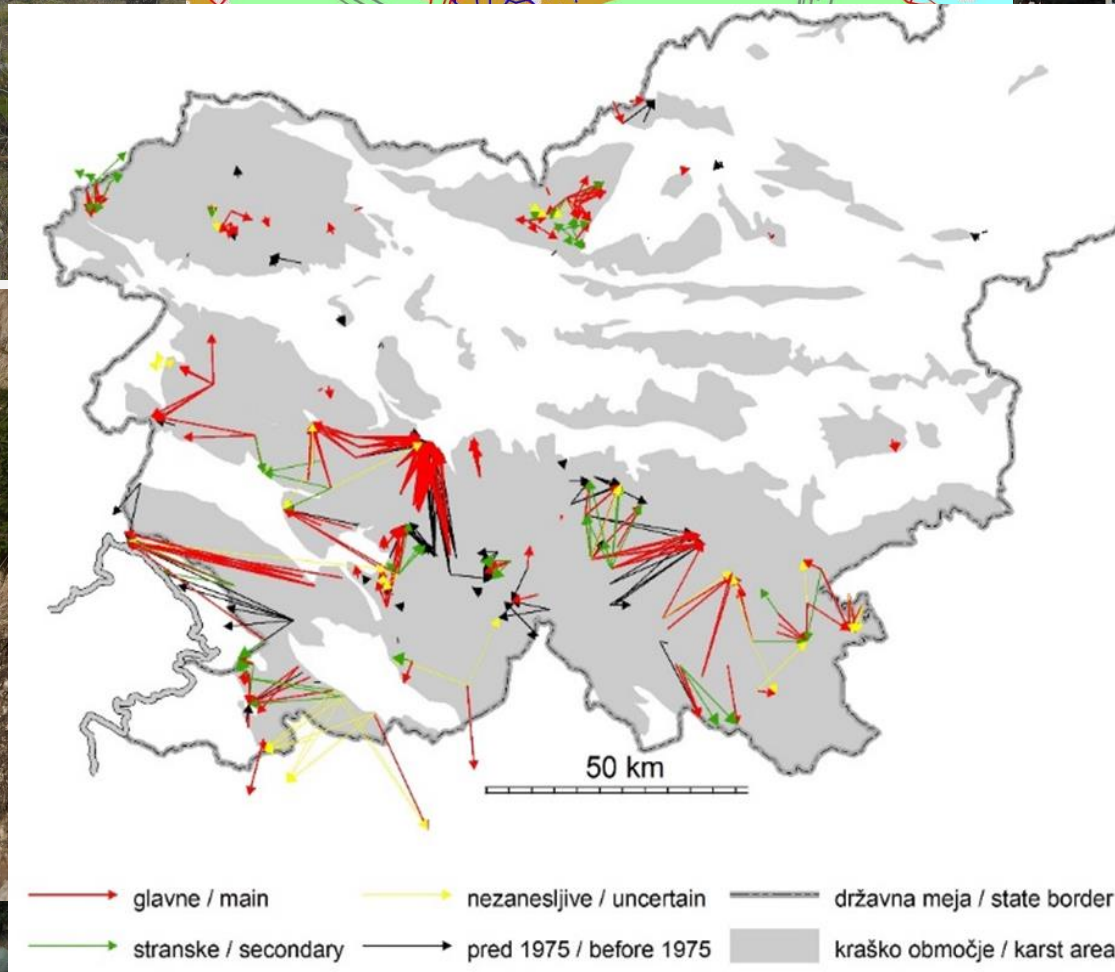
## CFD model nastanka faset



Razumevanje pretakanja vode skozi kras



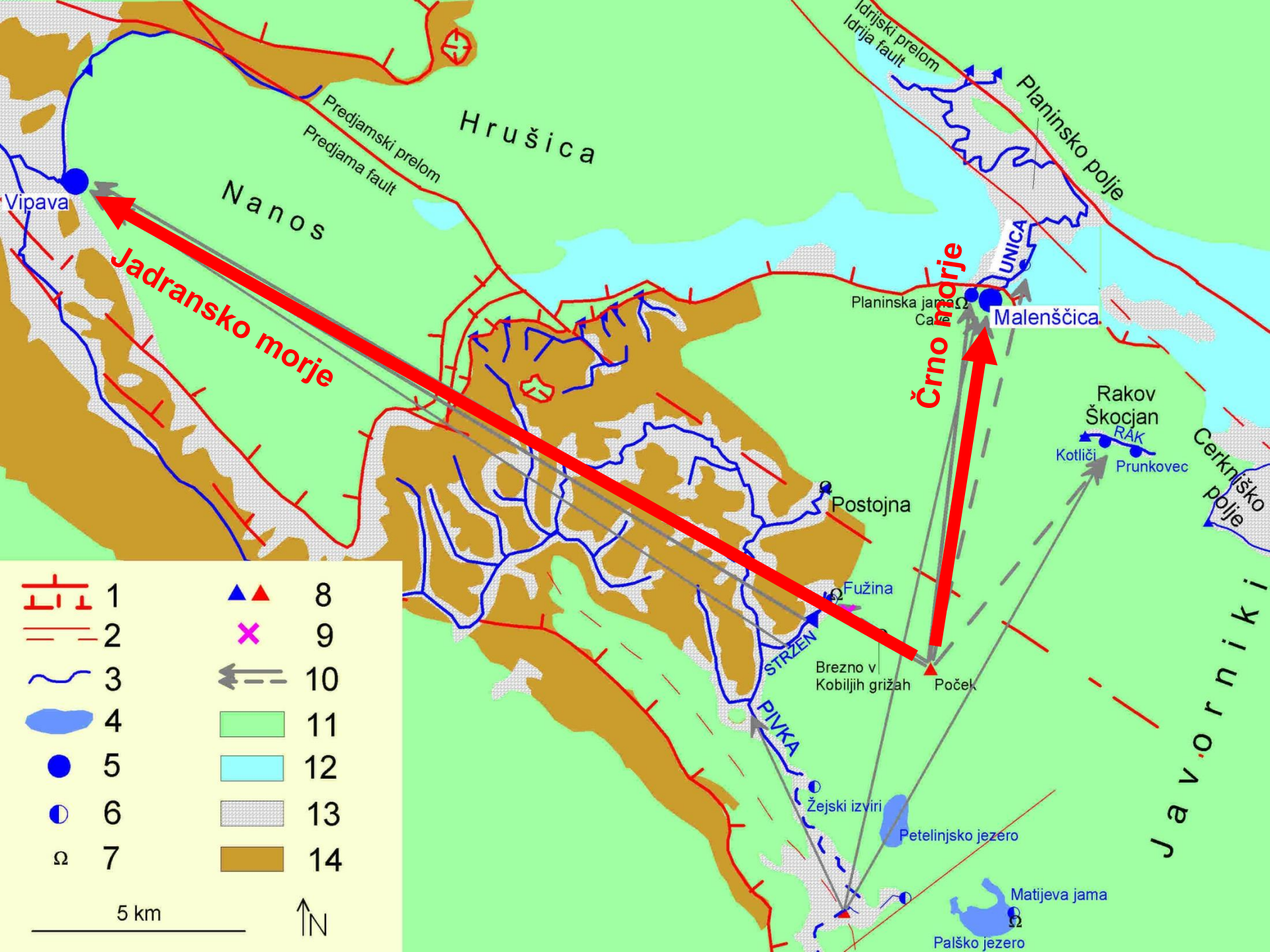
# Sledenje vodam



Neposredna uporabnost

(karte ranljivosti, oskrba z vodo in njeno varovanje, prometnice, ...)





- |  |   |  |    |
|--|---|--|----|
|  | 1 |  | 8  |
|  | 2 |  | 9  |
|  | 3 |  | 10 |
|  | 4 |  | 11 |
|  | 5 |  | 12 |
|  | 6 |  | 13 |
|  | 7 |  | 14 |

5 km

Jadransko morje

Črno morje

Hrušica

Nanos

Planinsko polje

Malenščica

Planinska jama  
Ca

Postojna

Fužina

Brezno v  
Kobiljih grizah

Poček

Žejski izviri

Petelinjsko jezero

Matijeva jama

Palško jezero

Rakov  
Škocjan  
RAK  
Kotličiči  
Prunkovec

Cerkljansko polje

Javorzniki

JUNICA

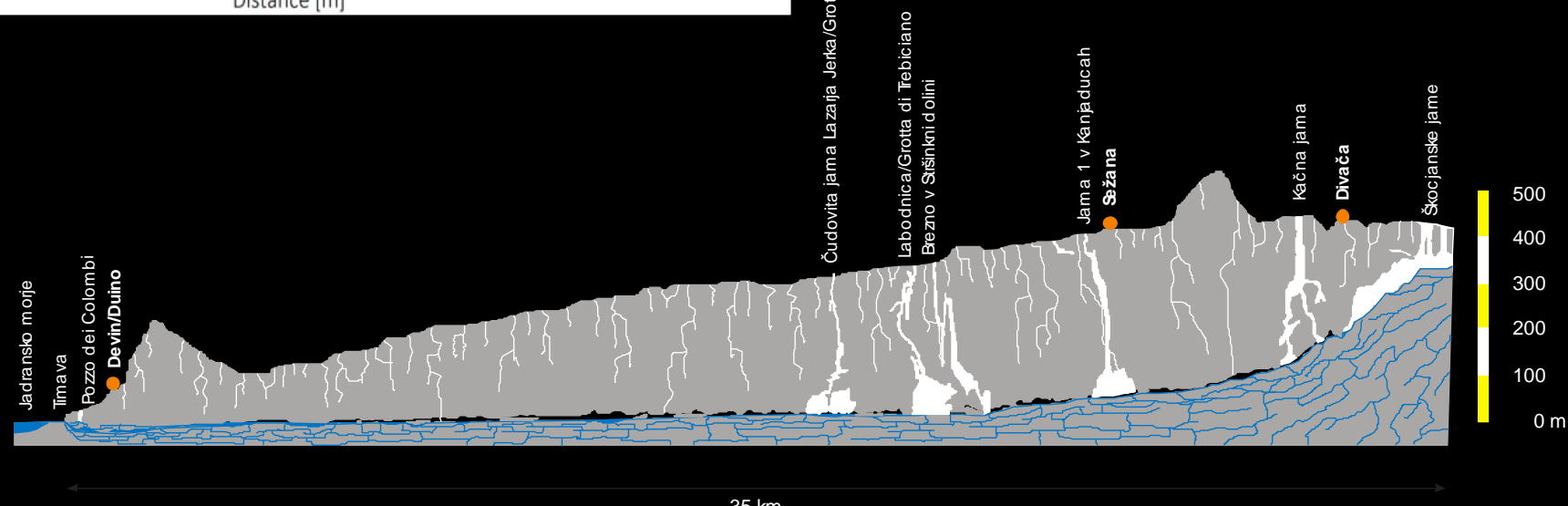
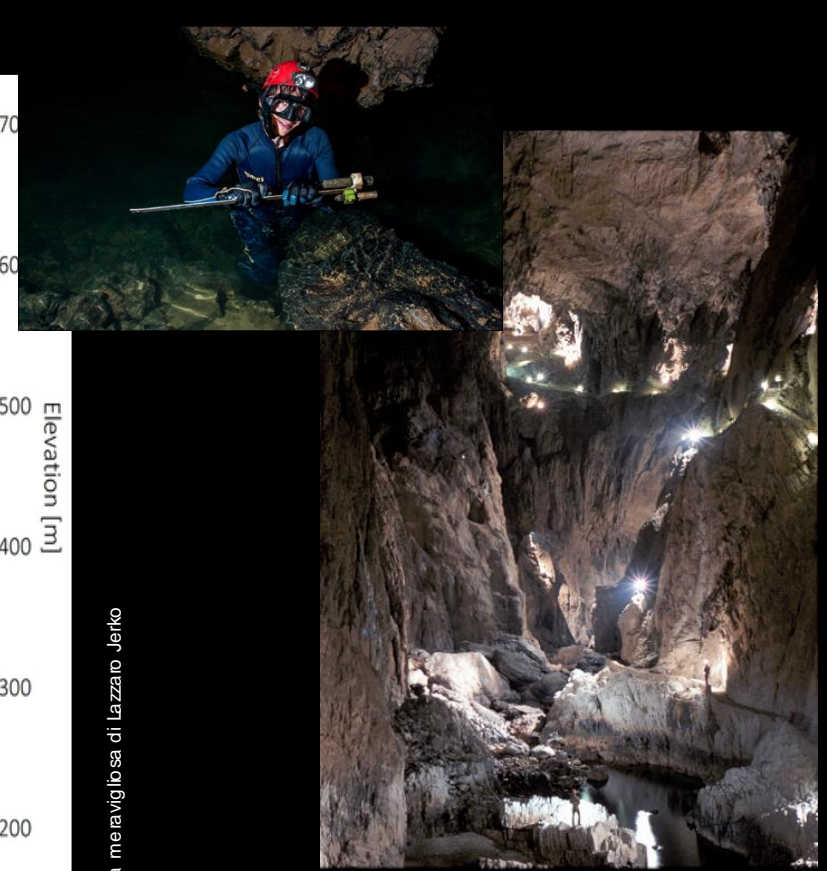
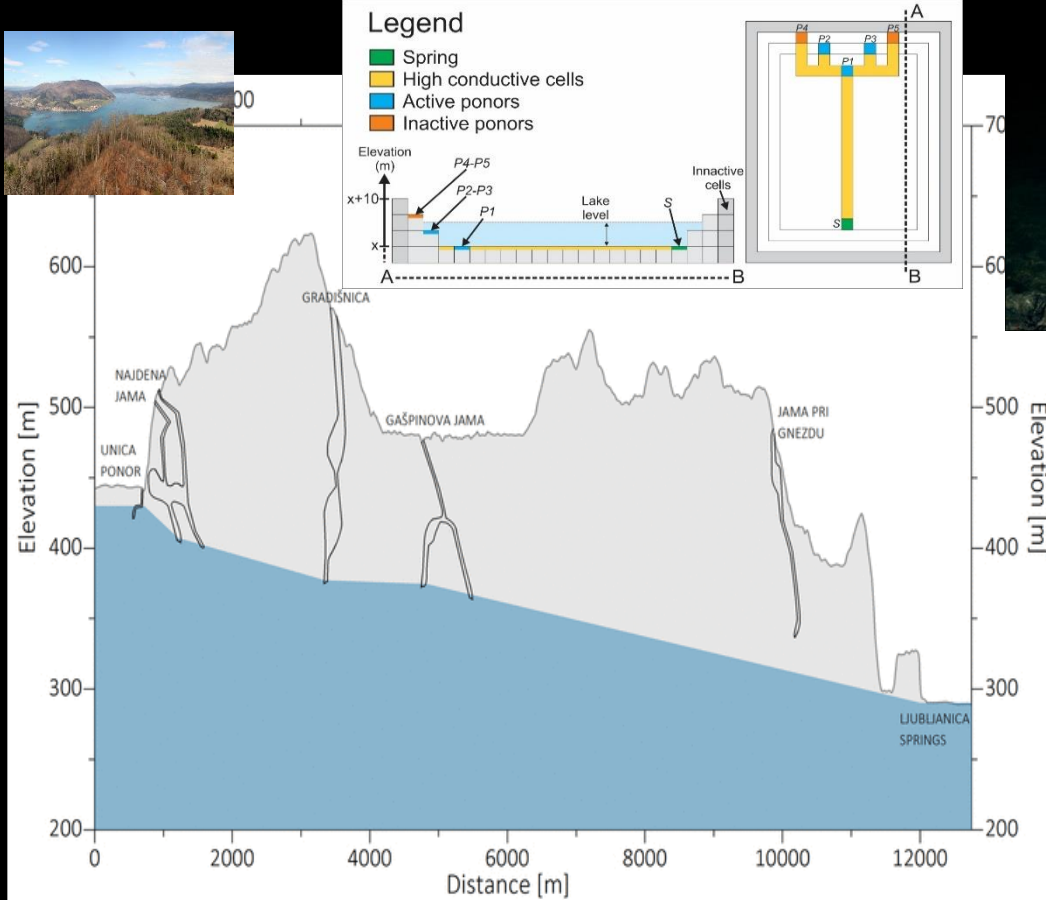
STRŽEN

PIVKA

Vipava

Predjamski prelom  
Predjama fault

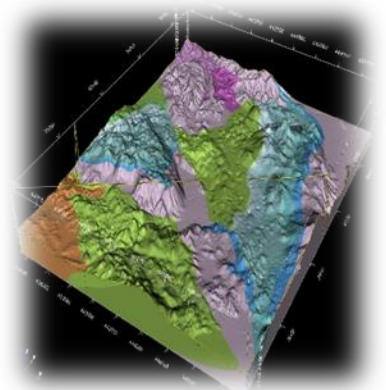
Idrijski prelom  
Idrija fault



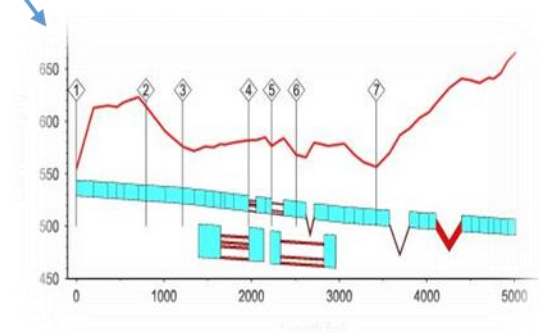
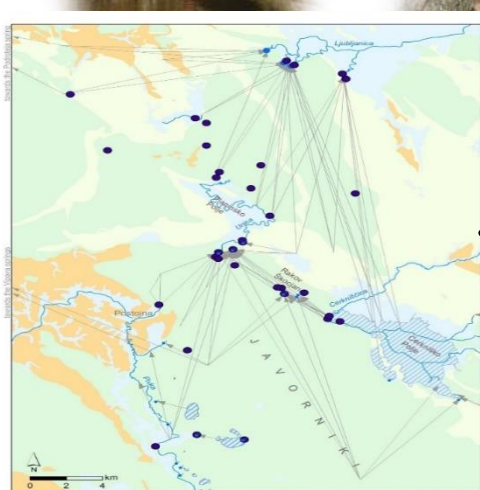


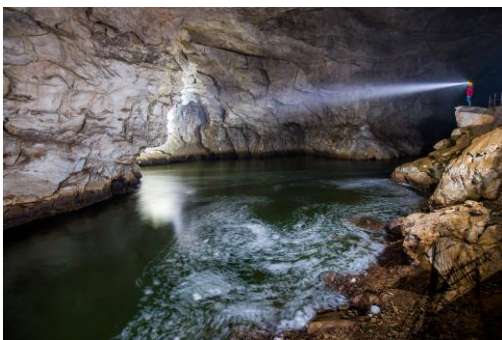
# Dolgotrajna merjenja:

- gladina vode,
- temperatura,
- električna prevodnost



*Izviri in ponori,  
jame,  
površinski vodni tokovi*





REGIONALNA HIDRODINAMIKA



OSKRBA Z VODO



POPLAVLANJE



ZAŠČITA IN UPRAVLJANJE  
NARAVNIH VIROV



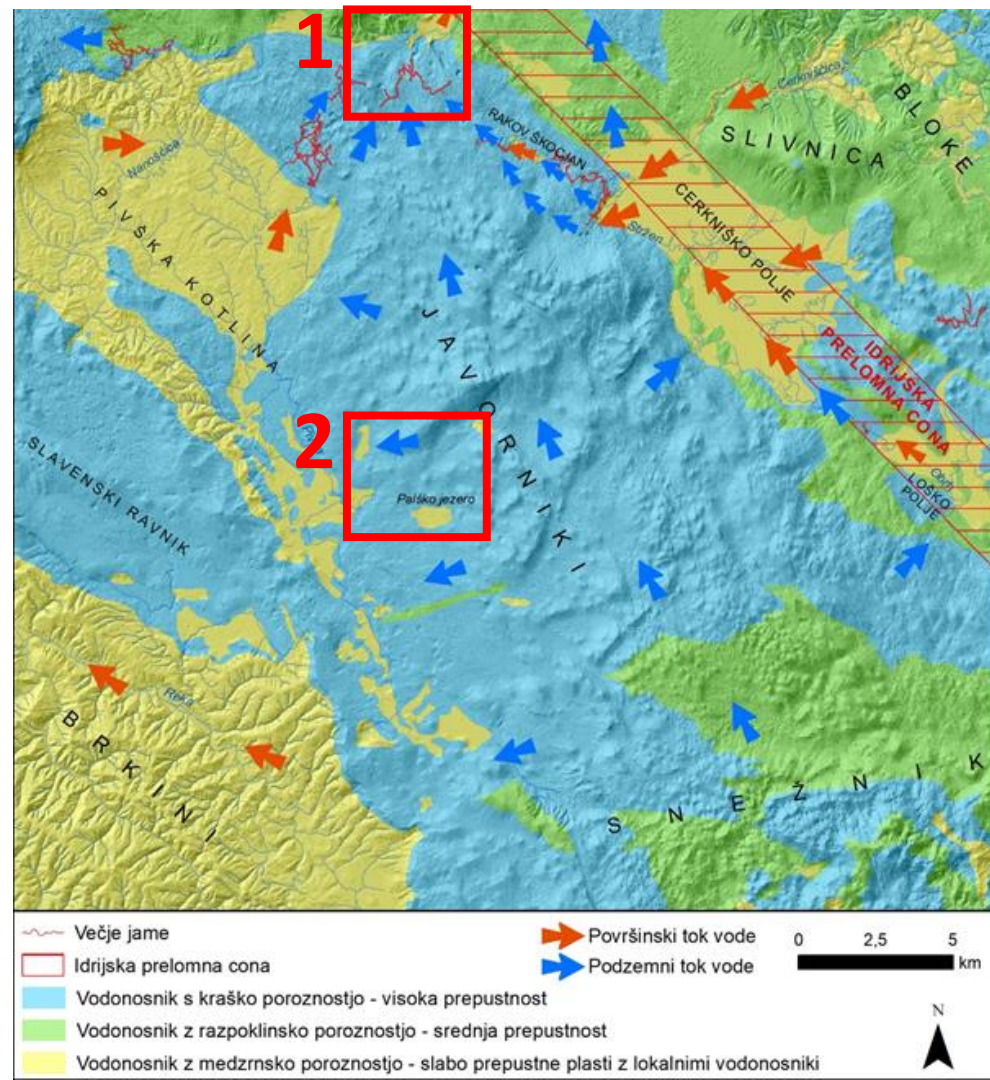
EKOHIĐOLOŠKE  
RAZISKAVE



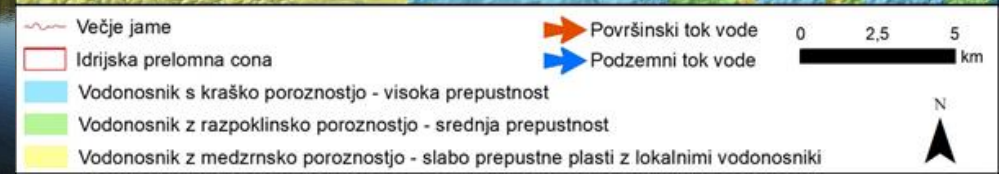
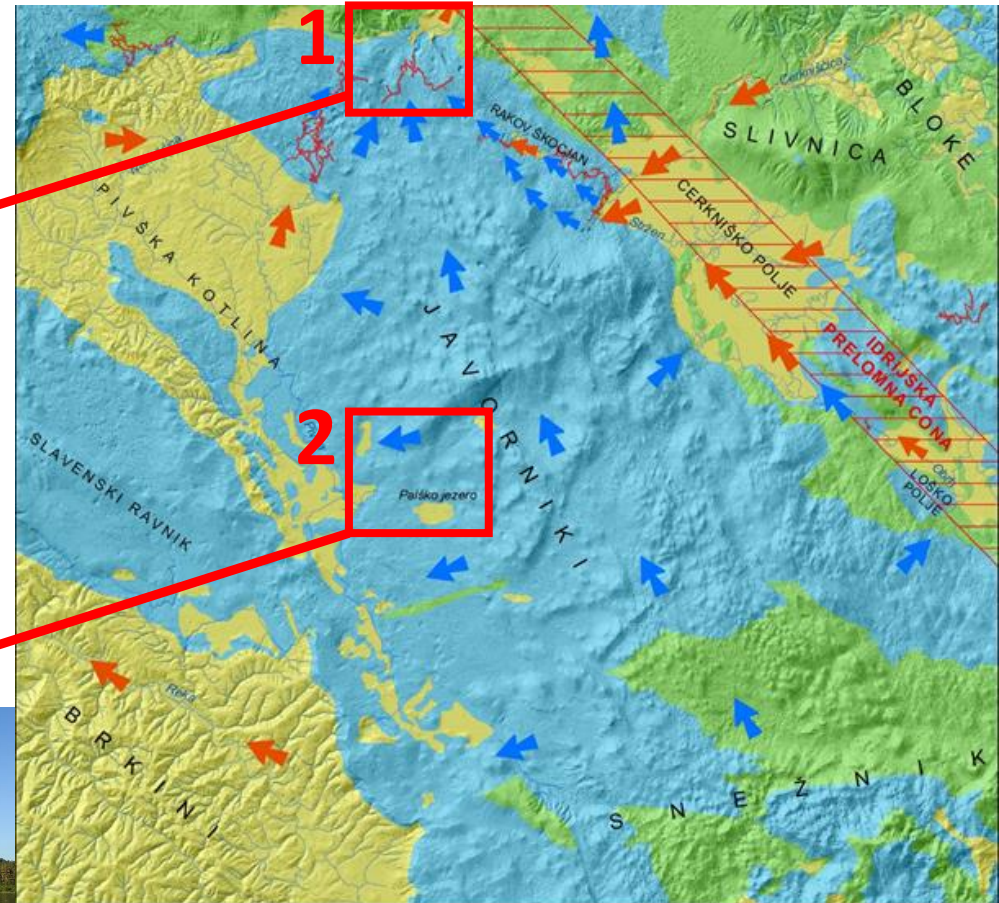
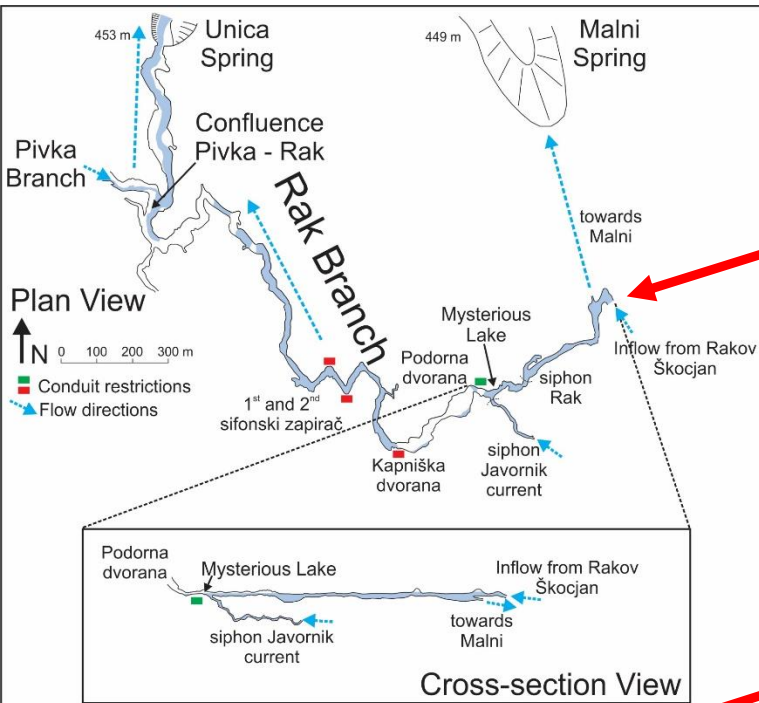
VAROVANJE NARAVNE IN  
KULTURNE DEDIŠČINE

# NOVI VIR 1 – kraški vodonosnik Javornikov

- Izvir Malni.
- Dotok vode s Cerniškega polja in skozi gorovje.
- Razlike med visokimi in nizkimi vodami.

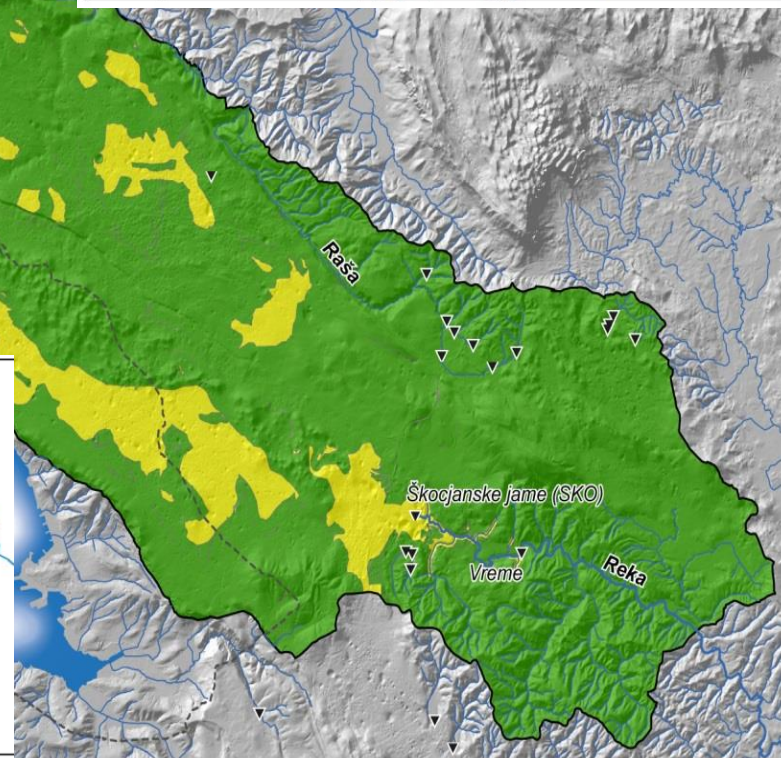
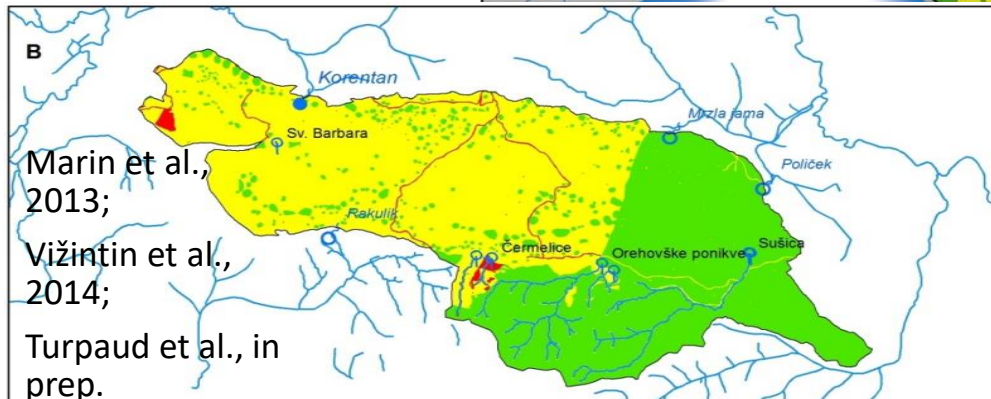
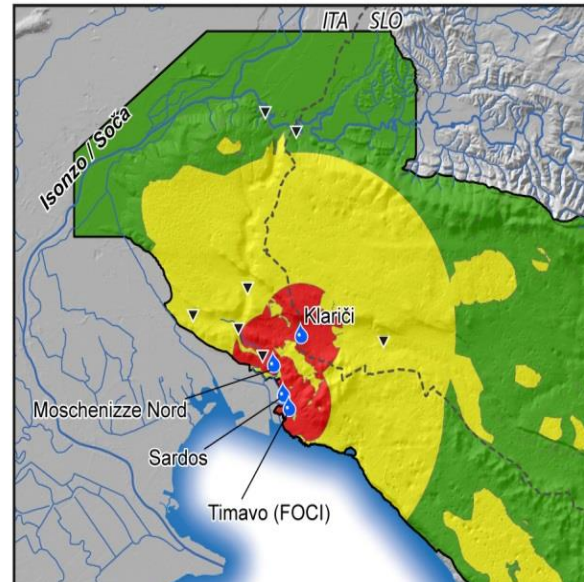
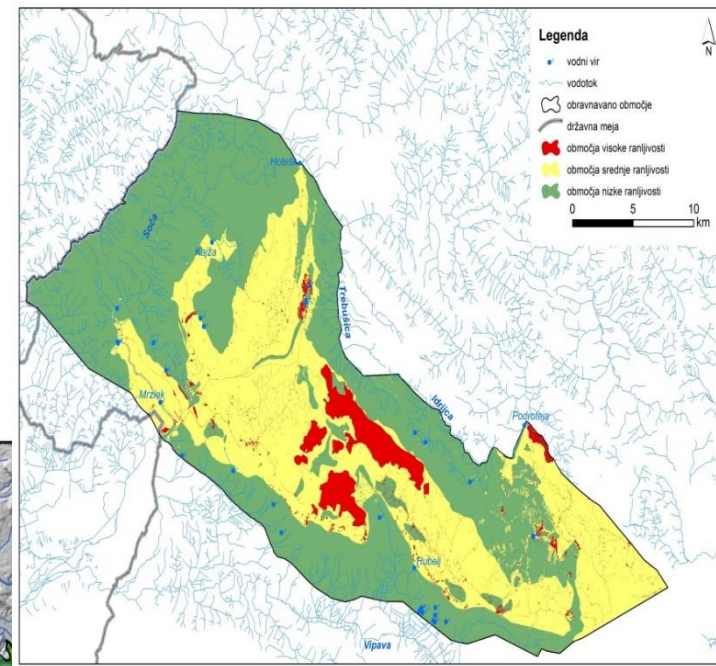


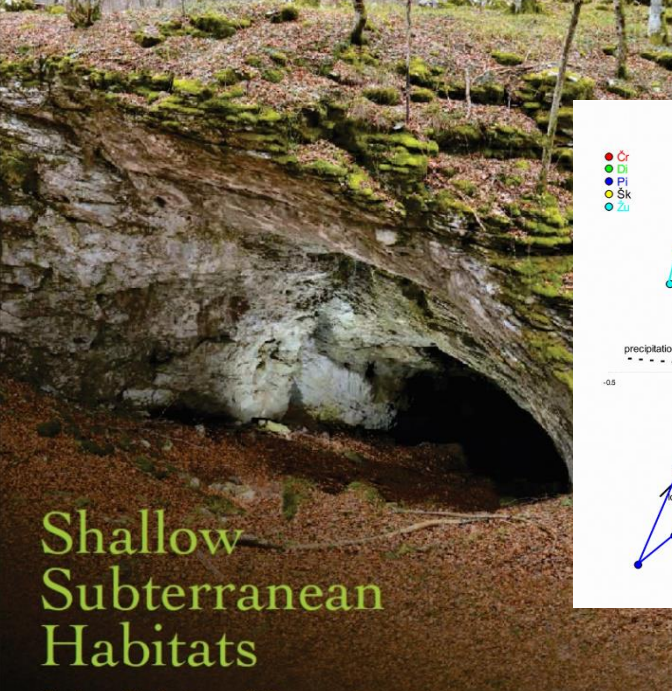
# NOVI VIR 1 – kraški vodonosnik Javornikov



# Ranljivost vodonosnikov

Za varovanje  
in ukrepanje

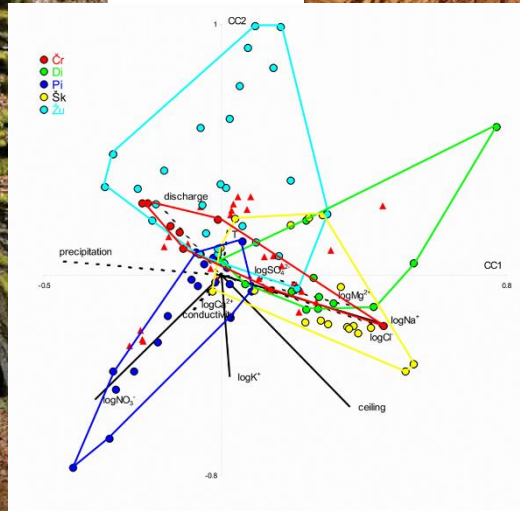




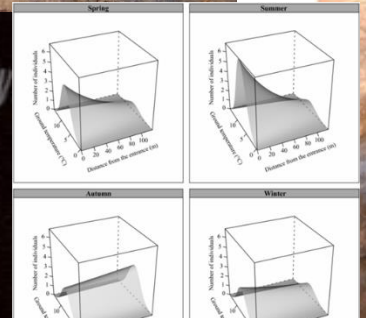
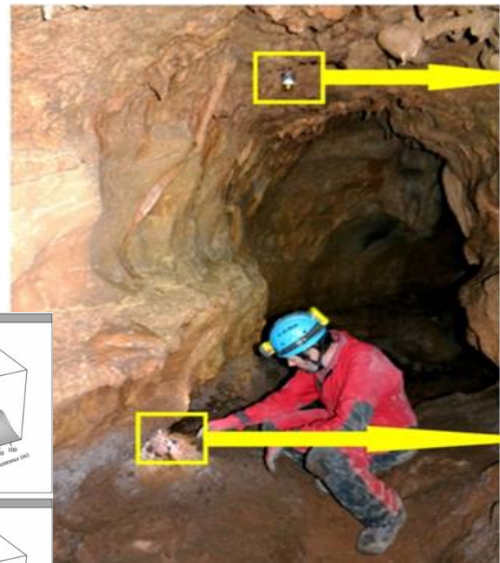
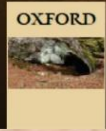
# Shallow Subterranean Habitats

*Ecology, Evolution, and Conservation*

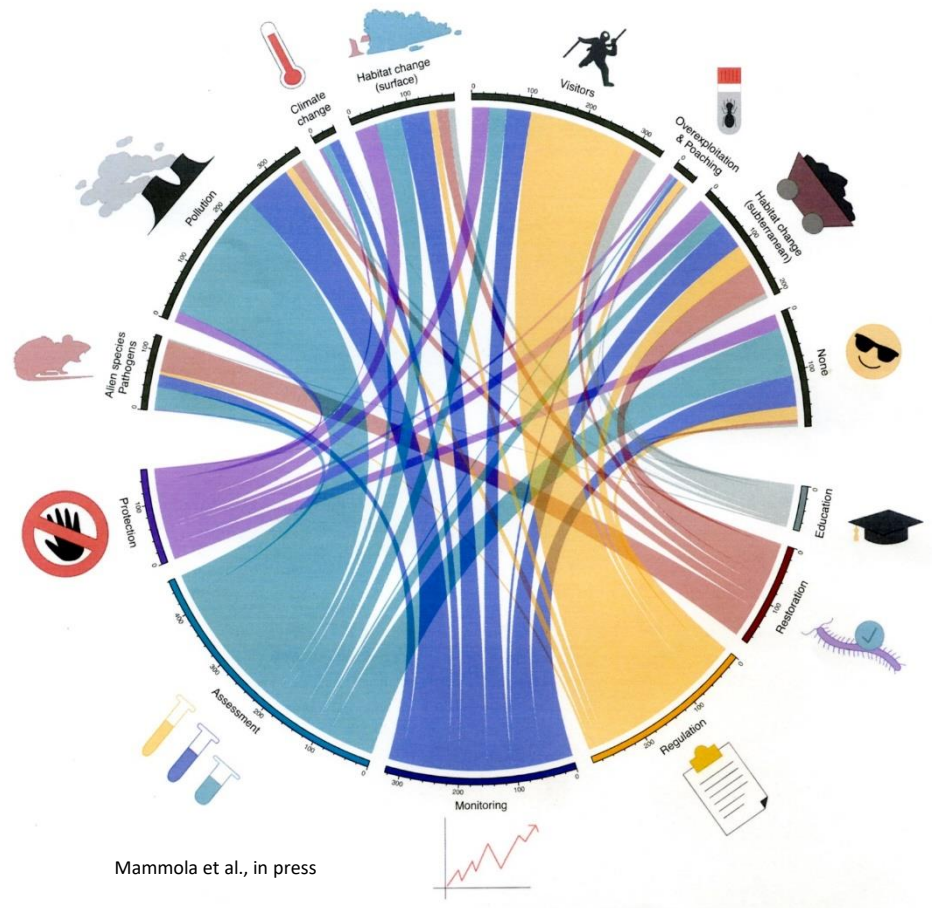
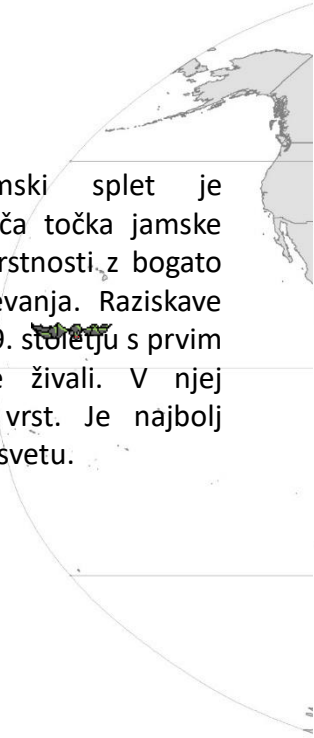
DAVID C. CULVER | TANJA PIPAN



# Speleobiologija

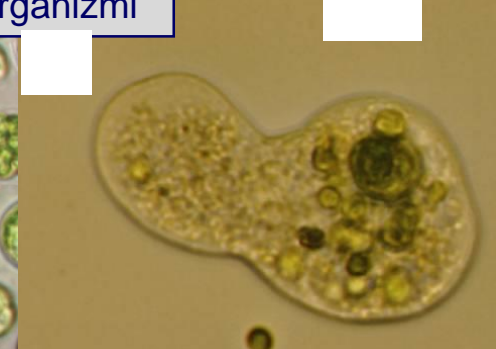
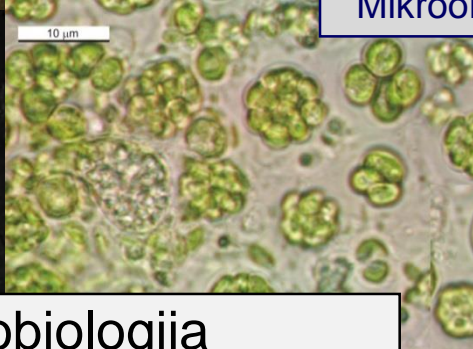
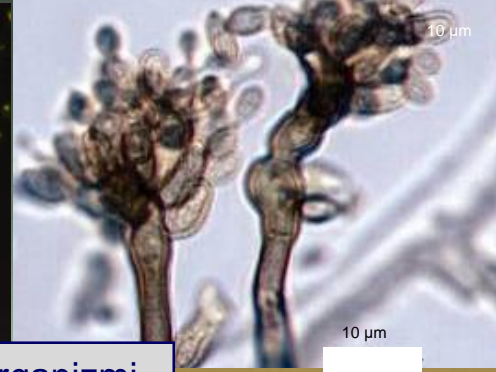
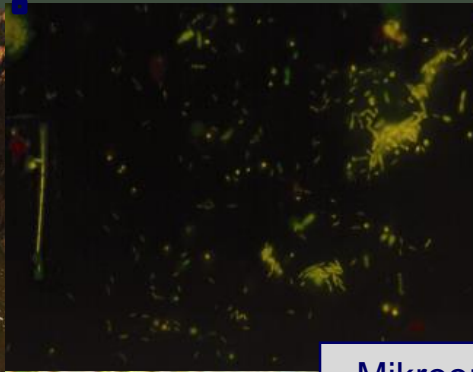


Postojnski jamski splet je pomembna vroča točka jamske biološke raznovrstnosti, z bogato tradicijo proučevanja. Raziskave so se začele v 19. stoletju s prvim opisom jamske živali. V njej poznamo 119 vrst. Je najbolj bogata jama na svetu.



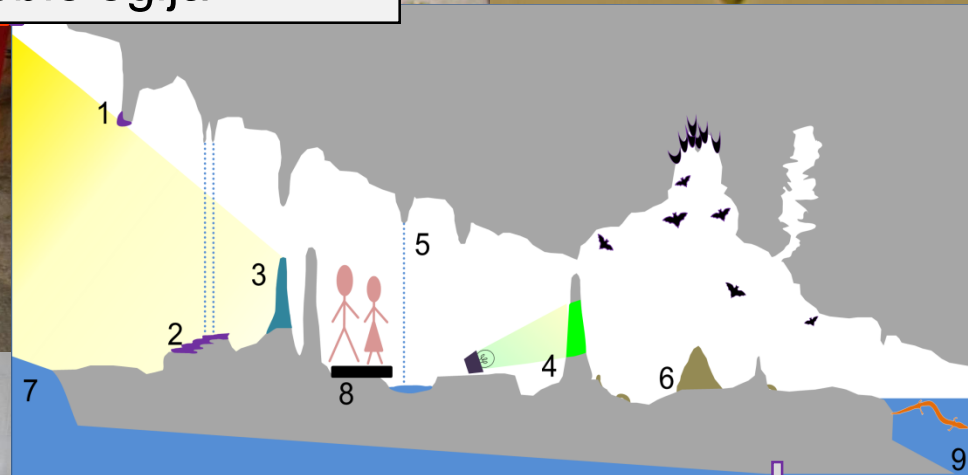
Mammola et al., in press





Mikroorganizmi

## Jamska mikrobiologija

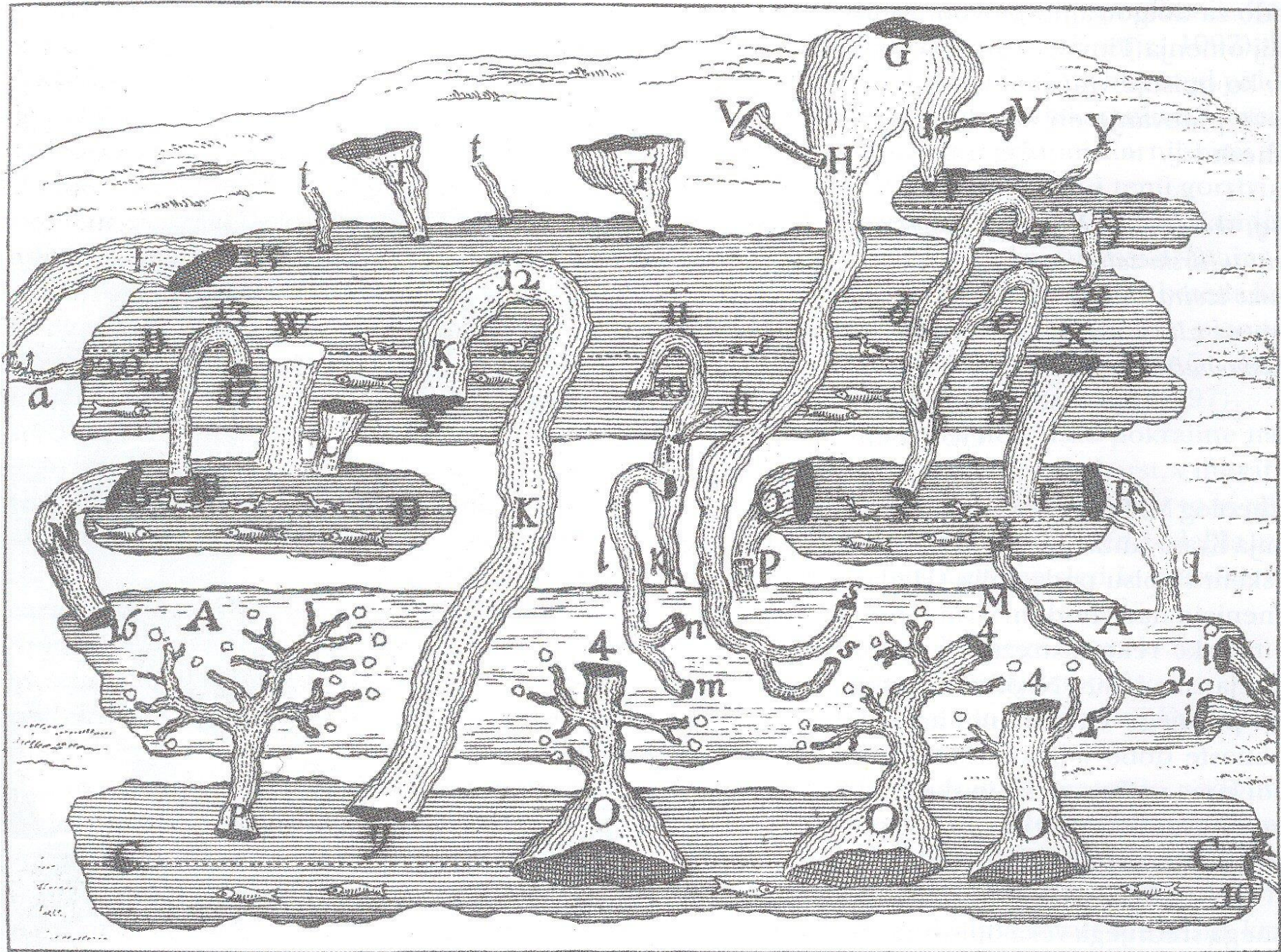


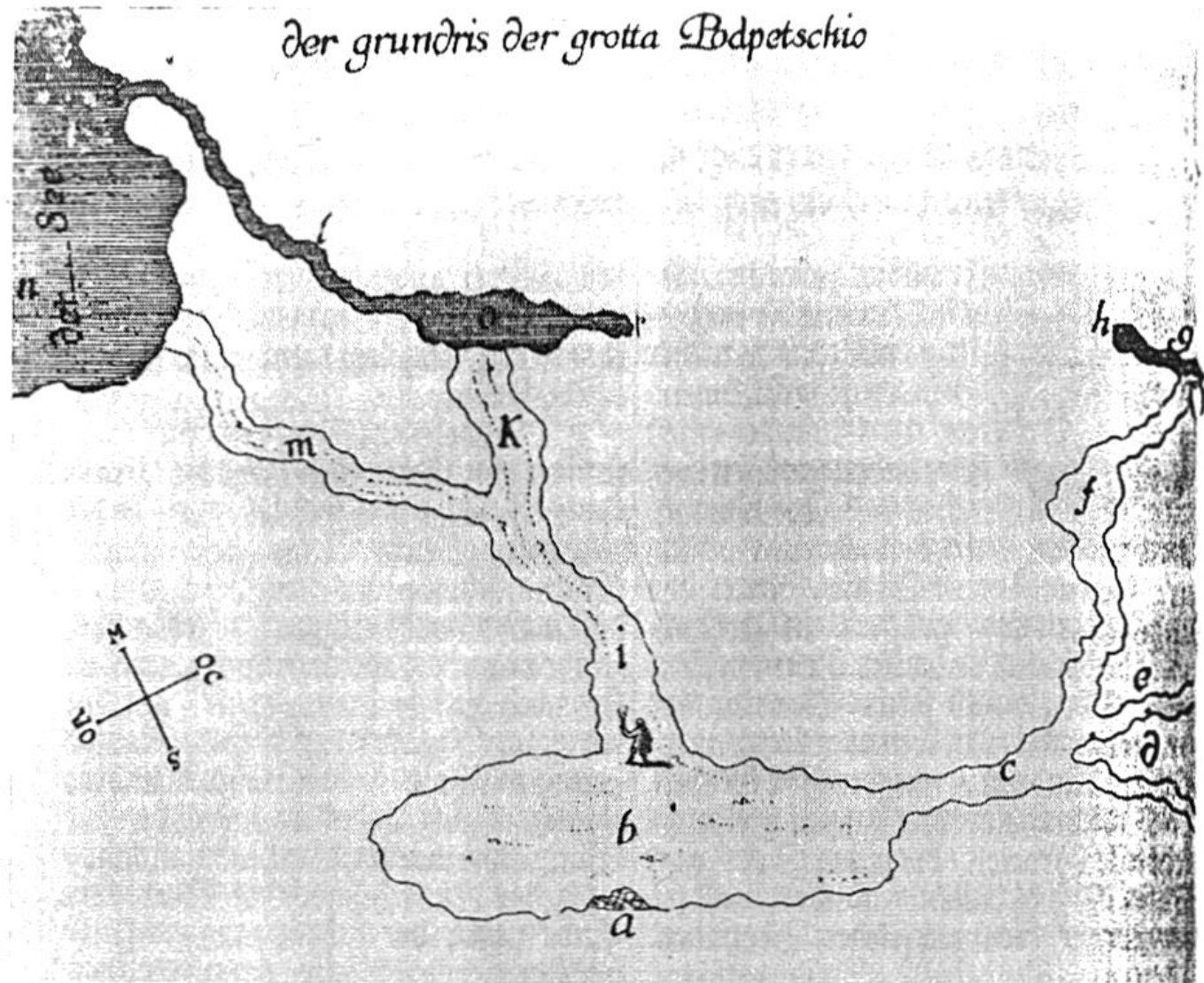
Urejanje jam za turizem



Entry points and some microbial habitats: 1 – stalactitic tufa, 2 – stromatolitic stalagmite, 3 – sun-illuminated surface of a speleotheme colonized by cyanobacteria, 4 – lampenflora around lamps in a tourist cave, 5 – dripping water introduces particles and organic carbon, 6 – guano under a bat colony, 7 – ponor of a river, 8 – tourist infrastructure and walking pathways, 9 – underground river flow and stigobitic animals







1 Valvazorjev načrt Podpeške jame (Dobrepolje) iz leta 1689. Foto V. Filač

## Kraško površje



## Jame



## Naravne značilnosti

Voda

Varovanje

KLIMA

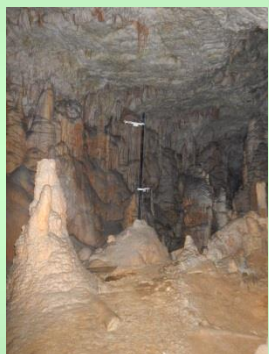
MINERALI

NAPLAVINE

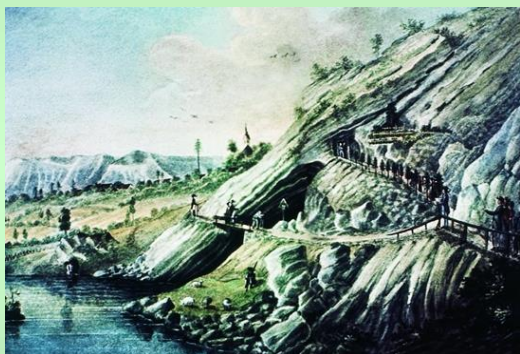
FAVNA

MIKROORGANIZMI

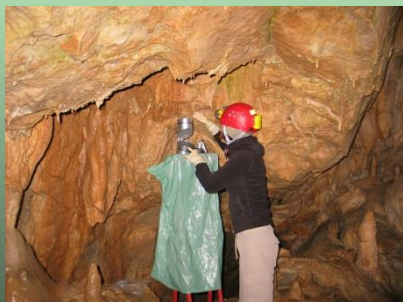
VODA



Merilna postaja



Postojnska jama



Vzorčenje zraka



Vzorčenje epikraške favne

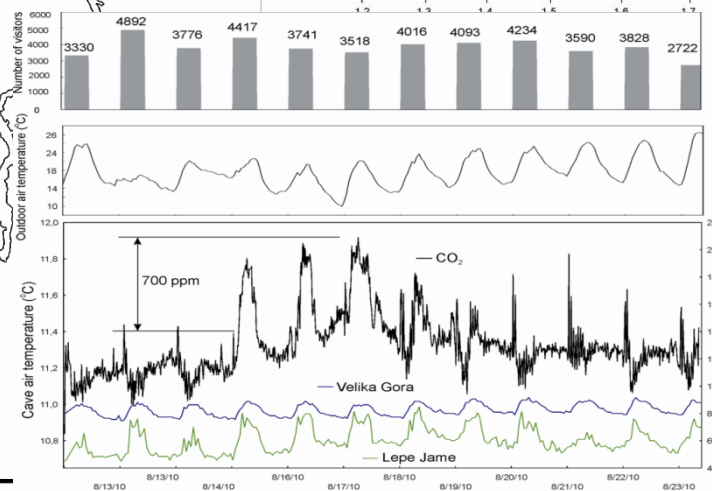
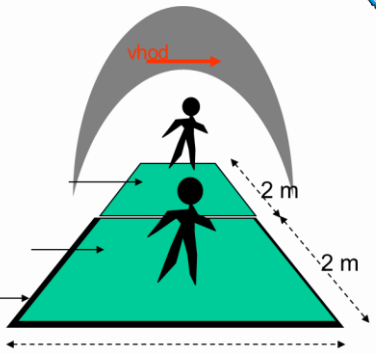
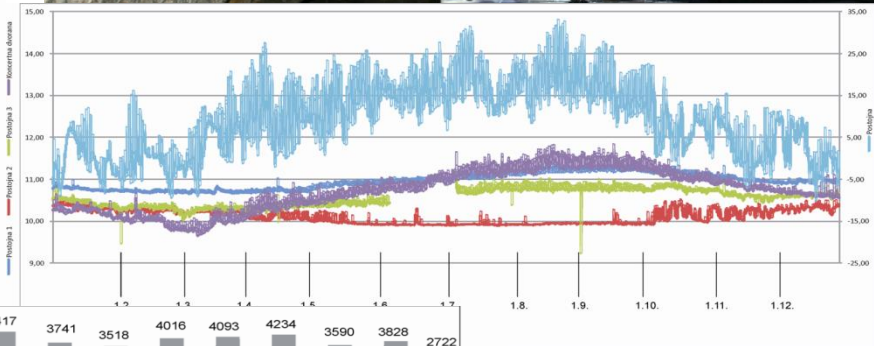
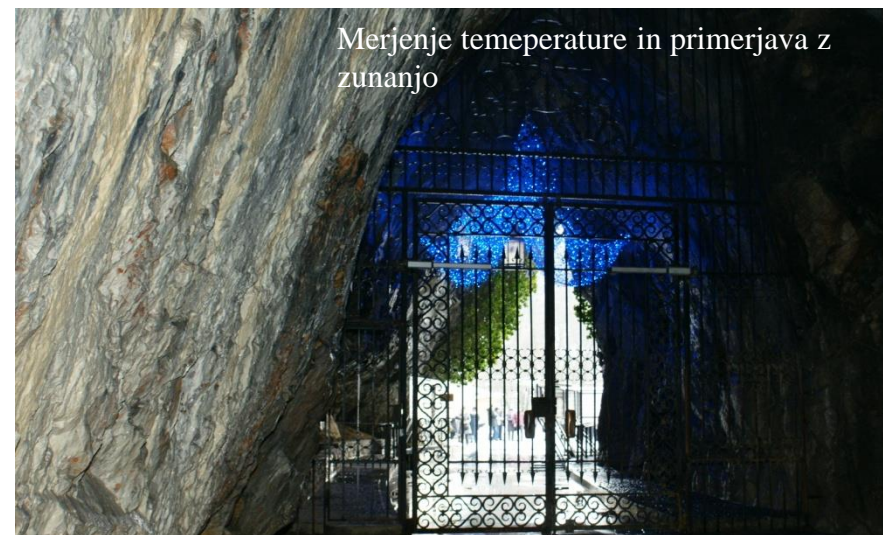
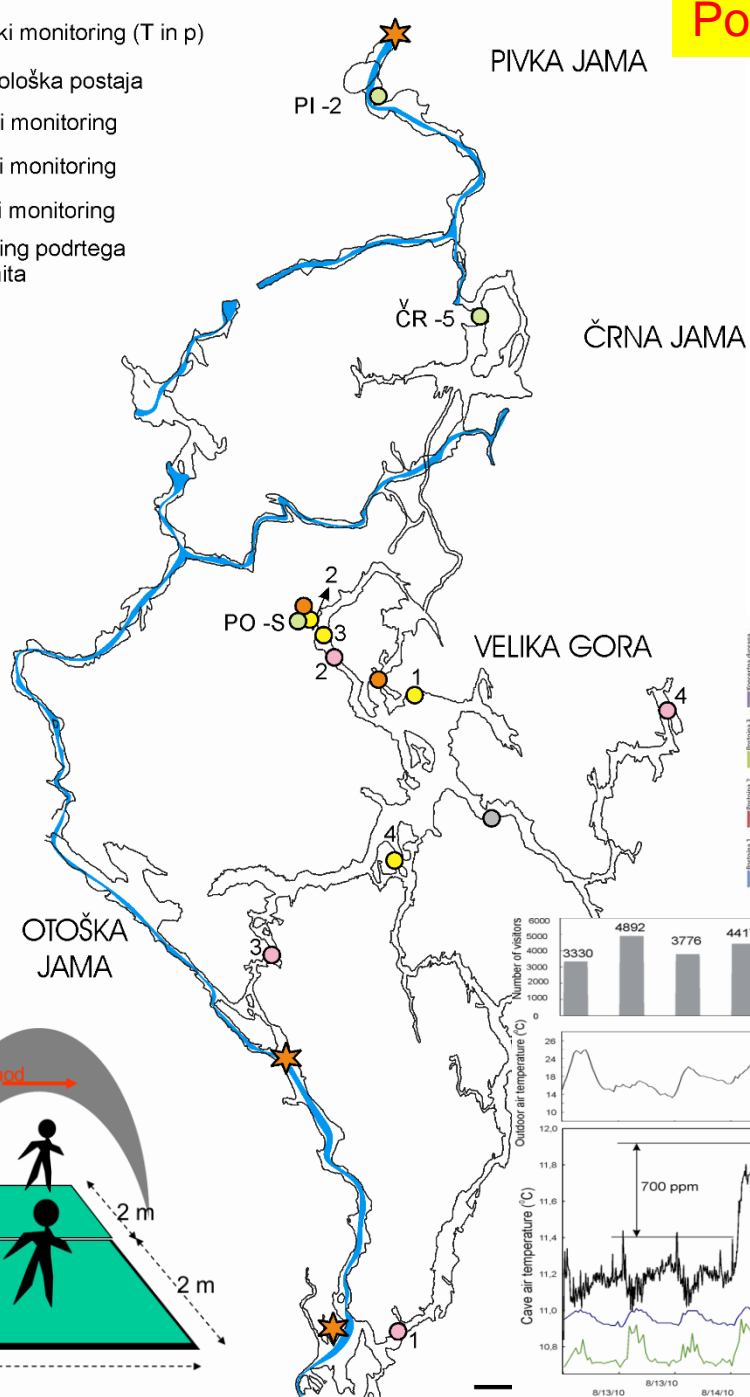


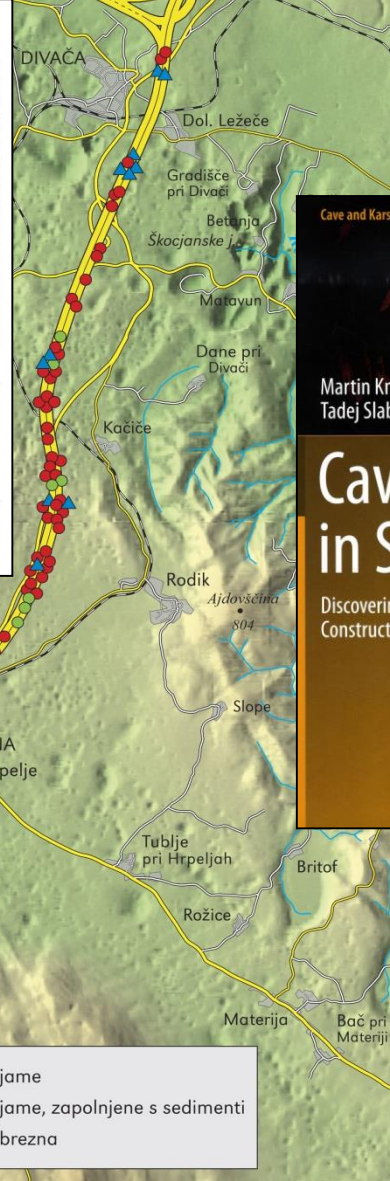
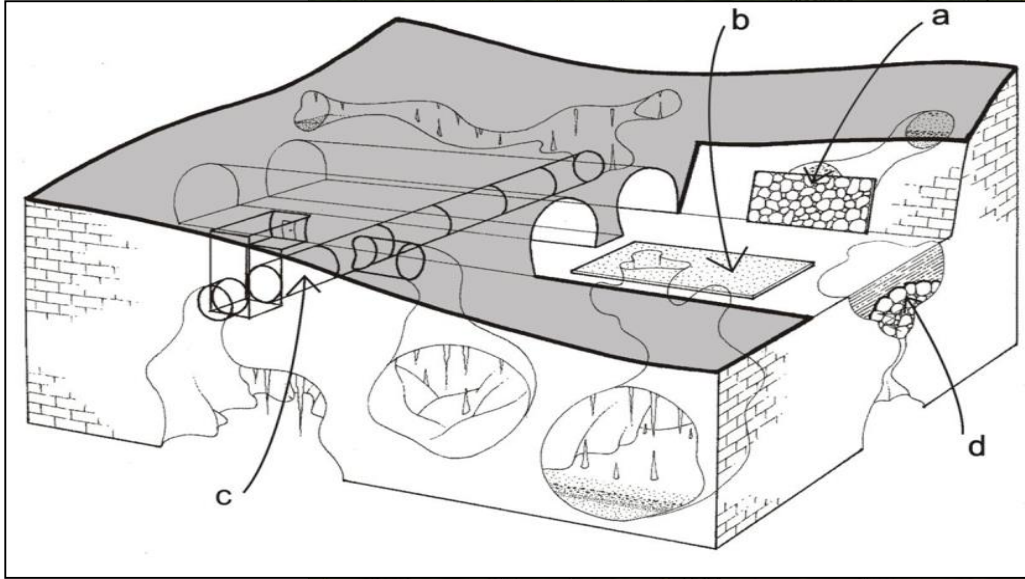
Vzorčenje naplavin

Legenda

- 1 ● Klimatski monitoring (T in p)
- 2 ● Meteorološka postaja
- 3 ● Biološki monitoring
- 4 ● Biološki monitoring
- 5 ★ Biološki monitoring
- 6 ● Monitoring podrtega stalagmita

# Postojnska jama





Cave and Karst Systems of the World

Martin Knez  
Tadej Slabe Editors

# Cave Exploration in Slovenia

Discovering Over 350 New Caves During Motorway Construction on Classical Karst

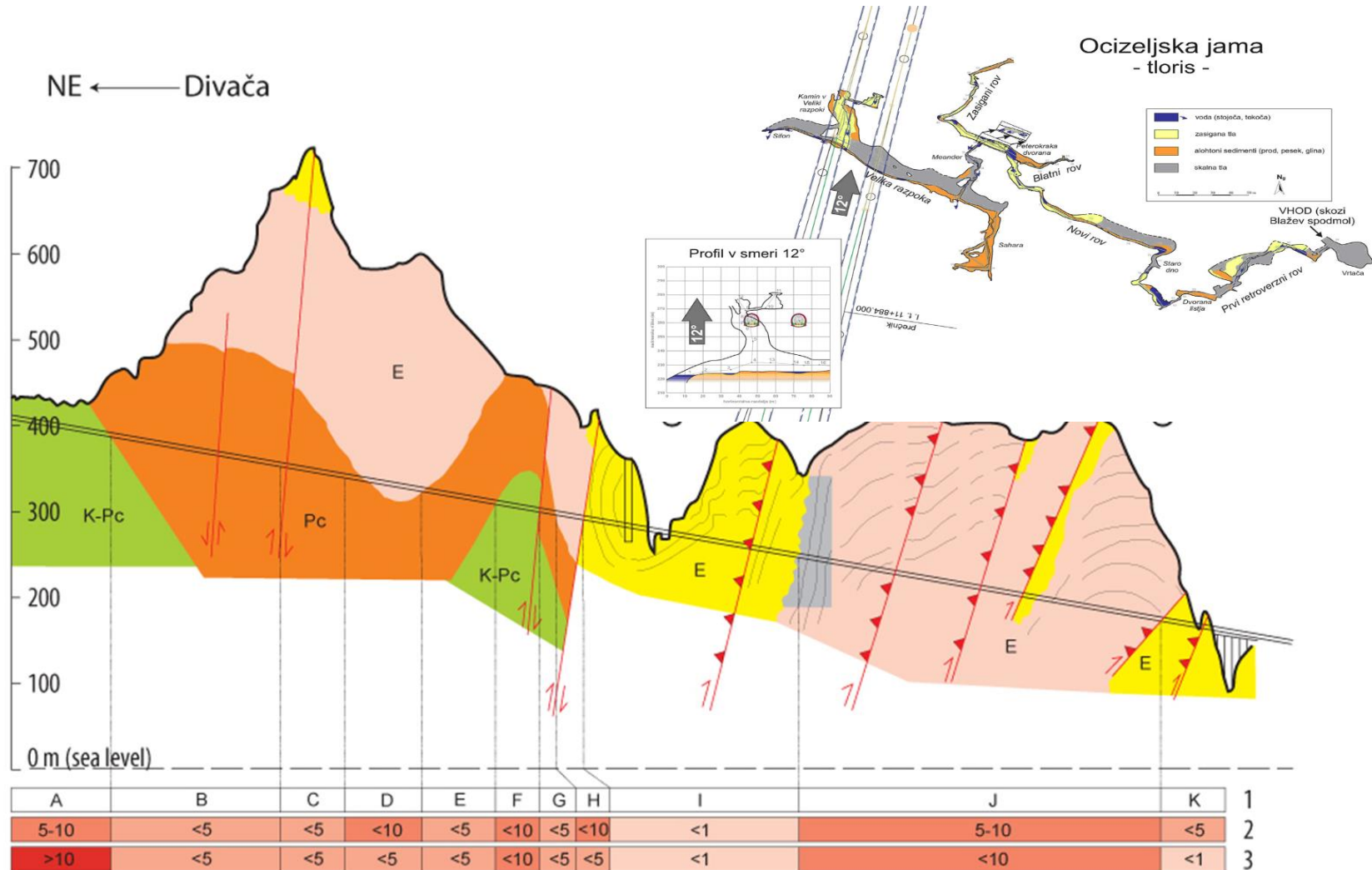
Springer



● jame  
● jame, zapolnjene s sedimenti  
▲ brezna

0 1 2 km

# Predvidene jame



Ocizeljska jama  
- floris -



VHOD (skozi Blažev spodmol)

Section 1

Density of caves (caves/km) 2

Diameter of caves (m) 3

# ACTA CARSOLOGICA



35/2 • 2006

SOUTH CHINA KARST II

# SOUTH CHINA KARST II

EDITORS: MARTIN KNEZ, HONG LIU, TADEJ SLABE

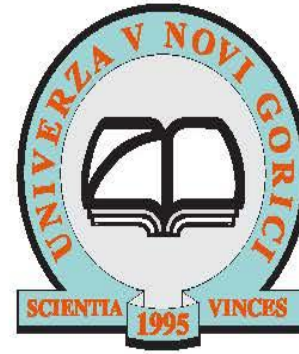


- Institute of Geology, the Academy of Sciences of the Czech Republic, Praha, Češka republika,
- Department of Geomorphology, Faculty of Earth Science, University of Silesia, Sosnowiec, Poljska,
- The National Karst Research Center of Iran, Water Resources Management Organization, Ministry of Energy of the Islamic Republic of Iran,
- Water Resources Division West Water Authority, Ministry of Energy, Kermanshah, Iran,
- Agencija Republike Slovenije za okolje, Urad za seizmologijo in geologijo, Ljubljana in Dipartimento di Scienze della Terra, Università degli studi di Trieste, Trieste, Italija,
- Rudarsko-geološka fakulteta Univerze v Beogradu, Srbija,
- Geography Department of Faculty of Arts, Alexandria University, Damanhour Campus, Egypt,
- Kowsar water & environment research center (K.R.C.), Tehran, Iran,
- Mammoth Cave National Park World Heritage Site, ZDA, Western Kentucky University, ZDA, IJZ Park Škocjanske jame, Divača in Turizem KRAS, destinacijski management d.d., Postojna,
- The International Research Centre on Karst under the auspices of UNESCO /Institute of Karst Geology, Chinese Academy of Geological Sciences, Guilin, China;
- Ukrainian Institute of Speleology and Karstology, Simferopol, Ukraine,
- National Cave and Karst Research Institute, Inc., Carlsbad, USA,
- Yunnan Institute of Geography, Yunnan University in ZRC SAZU / Agreement of Cooperation on the project: Research on the Karst Drinking water Source Security and the Early Warning Systems of the Dianchi Catchments, Kunming, China,
- International Research Center on Karst under the Auspices of UNESCO (IRCK) and ZRC SAZU / Protocol of The Technical Cooperation Meeting,
- School for Resource Environments and Earth Sciences, Yunnan Institute of Geography, Yunnan University in ZRC SAZU / Agreement on framework of "Yunnan University International Joint Research Center for Karstology,,,
- Yunnan Institute of Geography, Yunnan University (Kunming, China) / Agreement on framework of "Yunnan International Karst Environmental Laboratory",
- United Arab Emirates University, Al-Ain, UAE / Establishing the UNESCO Chair of Karstology at the University of Nova Gorica, Slovenia,
- Stone forest Research Centre of Stone Forest Scenic Spot Administration, Yunnan Province, China, International Joint Research Centre for Karstology of Yunnan University in ZRC SAZU Agreement on Three Parties' Establishing the Relationship of Friendly Partners Cooperative Research
- Memorandum of Understanding / Altaisky State Nature Biosphere Reserve,
- Memorandum of Understanding / Kosovo Environmental Protection Agency,
- Agreement of Cooperation between Yunnan Institute of Geography, Yunnan University and Karst Research Institute ZRC SAZU: Research on 3D Groundwater Managing Model of Typical Karst Fault Basin, Yunnan, China,
- Memorandum of Understanding Between the Graduate Program in Geography of PUC Minas and Research Centre of the Slovenian Academy of Sciences and Arts
- Cooperation Agreement between Pontificia Universidade Catolica de Minas Gerais, Brazil,
- Scientific, Educational and Cultural Cooperation Agreement for Post Graduate Activities in the Area of Karstology,
- Agreement of Cooperation in the area of Karstology and Related Sciences between The International Research Center on Karst under Auspicious of UNESCO (IRCK) and Institute of Karst Geology (CAGS), University of Nova Gorica and Research Centre of the Slovenian Academy of Sciences and Arts,
- Agreement of Cooperation in the area of Karstology and Related Sciences between Yunan University, University of Nova Gorica and Research Centre of the Slovenian Academy of Sciences and Arts,
- Joint Application Agreement of Cooperation on the Major Special project of 2016 - Research and demonstration on karst critical type and monitoring technology along One Belt and Road, Institute of Karst Geology, Chinese Academy of Geological Sciences,
- Agreement of Cooperation in the area of karstology and related sciences, Emirates Geographical Society in University of Nova Gorica.
- Joint Application Agreement of Cooperation on the Major Special project of 2016 - Research and demonstration on karst critical type and monitoring technology along One Belt and Road, Institute of Karst Geology, Chinese Academy of Geological Sciences,, 2017
- Agreement of Cooperation in the area of karstology and related sciences, Emirates Geographical Society in University of Nova Gorica, 2017
- Agreement of Cultural, Educational and Scientific Cooperation, Gorno-Altai State University, Altaisky State Nature Biosphere Reserve, UNG in ZRC SAZU, 2017
- Agreement of Cooperation in the area of karstology and related sciences, China Exploration & Research Society, UNG in ZRC SAZU, 2017
- Agreement of Cooperation in the area of Karstology and related sciences, Instituto de Geologia y Paleontologia, La Habana, Cuba, ZRC SAZU in UNG, 2018
- Memorandum on Understanding, ARSO, Urad za seizmologijo, Dipartimento di Matematica e Geoscienze Univesita' Degli Studi di Trieste, 2018
- Agreement of Cooperation in the area of Karstology and related sciences, Shahid Chamran University of Ahvaz, Iran, 2019
- Dogovor o sodelovanju, Univerza v Ljubljani, Biotehniška fakulteta, 2019
- Memorandum o razumijevanju i suradnji na sručnim, znanstvenim, istraživačkim, razvojnim i obrazovnim projektima, Sveučilište u Rijeci, Građevinski fakultet, UNG in ZRC SAZU, 2019





Organizacija Združenih narodov za izobraževanje, znanost in kulturo



- Krasoslovno študijsko središče Unesca
- Univerza v Novi Gorici v sodelovanju
- z ZRC SAZU Inštitutom za raziskovanje krasa
-



Marie Curie Actions

Human resources



and mobility

6<sup>th</sup> FP, Project SMART-KARST

15<sup>th</sup> International Karstological School Classical Karst  
“Management of transboundary karst aquifers”,  
Postojna, 18 – 24 June 2007



UIS



Mednarodno središče za  
raziskovanje krasa Junanske  
univerze

Kraški okoljski laboratorij



# KARSTOLOGY IN ARID REGIONS

Abu Dhabi, United Arab Emirates, 2-9 March 2015



# RAZISKOVALNE INFRASTRUKTURE= “objekti in storitve, ki jih znanstvena skupnost uporablja za izvajanje raziskav in spodbujanje inovacij” [European Strategic Forum on Research Infrastructures (ESFRI)]

## OKOLJSKE RAZISKOVALNE INFRASTRUKTURE V SLOVENIJI



**LifeWatch ERIC** (e-Science European Infrastructure for Biodiversity and Ecosystem Research)



**EPOS ERIC** (European Plate Observing System Research Infrastructure)



**eLTER ESFRI** (Integrated European Long-Term Ecosystem Critical Zone & Socio-Ecological Research Infrastructure)

## 12 PARTNERJEV V TREH SLOVENSKIH RI KONZORCIJAH



GOZDARSKI INŠTITUT SLOVENIJE  
SLOVENIAN FORESTRY INSTITUTE

Univerza v Ljubljani



IZRK ZRC SAZU

Vodilni partner



Park Škocjanske jame,  
Slovenija



Jožef Štefan  
Institute



PRIRODOSLOVNI MUZEJ SLOVENIJE



TULAR CAVE LAB



University of Maribor



NALOŽBA V VAŠO  
PRIHODNOST

Naložbo sta sofinancirala  
Evropska unija in  
Republika Slovenija  
**Razvoj raziskovalne  
infrastrukture za  
mednarodno  
konkurenčnost  
slovenskega  
RRI prostora –  
RI-SI-LifeWatch**



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infrastrukture za  
mednarodno  
konkurenčnost  
slovenskega  
RRI prostora –  
RI-SI-EPOS**



# ***MEDNARODNO LETO JAM IN KRASA 2021***

*“Raziskovanje, razumevanje in  
varovanje*

# Izzivi

- Poglobljanje temeljnega znanja o krasu,
- trajen razvoj celostnega krasoslovja,
- ureditev in uporabnost krasoslovnih izsledkov za razvoj družbe na krasu,
- kras in krasoslovje kot skupno dobro,
- trajnostni razvoj kot celostni socialni, demokratični in okoljski cilj,
- vloga v znanstveni politiki (Slovenija, EU, širše),
- mednarodna vloga v krasoslovju,
- evropsko krasoslovno središče (JRC),
- krasoslovje kot samostojna veda,
- eno vodilnih mednarodnih raziskovalnih in študijskih krasoslovnih središč.